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Brucellosis in Africa

Part I: The Prevalence

C.C. CHUKWU
Tropical Veterinary Science Department, James Cook University of North Queensland, Townsville, Queensland 4811, Australia*

Summary
Reports from many African countries indicate that there is a high prevalence of brucellosis in cattle. The disease also occurs in man, sheep, goats, camels, dogs and wild life. The species of Brucella isolated include Br. abortus, Br. melitensis, Br. ovis, Br. canis and Br. suis. Br. abortus biotypes 1, 2, 3, 4, 6, 7, 8 and 9 and biotypes 1, 2 and 3 of Br. melitensis have been identified in Africa. A more extensive survey of the prevalence of brucellosis in Africa is suggested so as to establish the exact health status of animals and man.

Introduction
Brucellosis is found in practically every country of the world. The disease affects man, domestic animals and wildlife. It is caused by Br. abortus, Br. melitensis, Br. suis, Br. ovis and Br. canis.

Brucellosis is not new in Africa. From the time of Hippocrates (about 450 BC), a mild type of recurrent fever was known in the Mediterranean countries. It has been called 'Mediterranean fever'. In 1887 David Bruce isolated Micrococcus melitensis from the spleens of patients who had died of undulant fever. In Kenya animal brucellosis was first reported in 1914 (Anon). It is on record that undulant fever caused by Br. abortus was first recognized in the Orange Free State in 1915 (Neitz 1965). Bevan (1921-22) drew attention to the presence in Southern Rhodesia of cases of human brucellosis in people who had had contact with goats. Abortions were common in cattle in these areas, and it appeared that the Rhodesians became infected by consuming unpasteurised cows' milk. This observation aroused the interest of many investigators, and before long undulant fever caused by Br. abortus was reported from many parts of the world. In Africa, the first positive diagnosis of Br. ovis was made in the Republic of South Africa by Van Rensburg et al. (1958). Br. canis was first described by Carmichael and Bruner (1968) as the cause of canine abortions in Beagles in the United States. This organism has been isolated from exotic dogs in Nigeria by Okoh et al. (1978). This first part of this paper reviews the prevalence of brucellosis in man and animals in Africa; the second reviews the economic, public health and veterinary importance of the disease, while the third suggests methods of eradication of bovine brucellosis in Africa.

Biotyping
Reports on biotyping of Brucella organisms in Africa have been documented. Philpott and Auko (1972) reported the isolation of biotypes 1, 2 and 3 of Br. melitensis from sheep and goats in Kenya. Hummel and Staak (1974) found all isolates of Br. abortus in Tanzania to be biotype 3. Br. abortus biotypes 1, 3 and 9 have been isolated in Kenya (Waghela, 1976). Four isolates of Br. abortus in the Republic of South Africa were found to be biotype 1 (Gradwell et al., 1977). Biotyp 7 has been described in Egypt and South Africa (Elliott and Christiansen, 1977). In Uganda Br. abortus biotypes 3, 8 and 9 have been isolated (Elliott and Christiansen, 1977). Eze (1978) isolated biotypes 1 and 2 of Br. abortus from Nigerian cattle. Bale and Kumi-Diaka (1981) isolated biotypes 1, 3 and 4 in Nigeria. Br. abortus biotypes 1 and 3 have been described in Senegal with a very strong predominance of biotype 3 (Verger et al., 1979). Of 17 isolates of Br. abortus from cattle in the Ivory Coast, nine were of biotype 1 and eight of biotype 6 (Pilo-Moron et al., 1979). Thirty strains of Br. abortus isolated from hygroma fluid of cattle in Togo were identified as biotype 3 (Verger et al., 1982). Recently Andreani et al. (1983), working in

* Present Address: Department of Veterinary Medicine, University of Nigeria, Nsukka, Anambra State.
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RBT = Rose Bengal test; SAT = Serum agglutination test; CFT = Complement fixation test; MRT = Milk ring test; CAT = Coombs antiglobulin test; HIT = Heat inactivation test; RT = Rivaniol test; MET = 2-Mercaptoethanol test; ? = Data not supplied.
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RBT = Rose Bengal test; SAT = Serum agglutination test; CFT = Complement fixation test; MRT = Milk ring test; CA1 = Coombs antiglobulin test; HIT = Heat inactivation test; RT = Rivanol test; MET = 2-Mercaptoethanol test; ? = Data not supplied.
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RBT = Rose Bengal test; SAT = Serum agglutination test; CFT = Complement fixation test; MRT = Milk ring test; CAT = Coombs antiglobulin test; H11T = Heat inactivation test; RT = Rivanol test; ME1 = 2-Mercaptoethanol test; ? = Data not supplied.

the Somalia Democratic Republic, isolated *Br. abortus* biotype 6 from milk of an infected cow.

**Discussion**

The prevalence of brucellosis in Africa is presented in Table 1. The 1978 Food and Agriculture Organisation (FAO) Animal Health Year Book indicated that there is a high prevalence of bovine brucellosis in Africa. These reports are in good agreement with the data presented in this review. The high prevalence is probably due to the fact that many countries have not yet started control or eradication schemes.

*Brucella* infection of sheep and goats is also important in some African countries (Philpott and Auko, 1972; Waghela, 1976; Akoh, 1980). *Br. suis* infection of swine has been reported in Mali, Nigeria and Zaire, while *Br. ovis* infection of sheep was reported in South Africa, Namibia, Niger and Mali (FAO, 1978). However, only a few African countries have ever carried out an extensive survey of the prevalence of brucellosis in animals or man. Most or all of the surveys reported were conducted on selected herds or persons in some parts of the country. It is therefore difficult to arrive at a national average for each country. Consequently, all the data must be considered critically. An
extensive survey of the prevalence of brucellosis in domestic animals is strongly recommended. This will help to establish the exact health status of the animals in the continent.

The importance of *Brucella* infection in game animals in Africa has not been elucidated. The observation that these animals may be a source of human brucellosis (Schiemann and Staak, 1971) is quite interesting and should be investigated further. Nothing is yet known about what antibody titres should be regarded as indicative of *Brucella* infection in these animals. Work is therefore required to establish an appropriate positive titre to *Brucella* organisms in these animals and to investigate the part they may play in the spread of brucellosis to domestic animals. It is likely that these species initially became infected by direct or indirect contact with domestic animals and *vice versa*. This might be expected where domestic animals share the same pastures with wild life. However, the prevalence in some of the species (hippopotamuses and buffalos) is too high to be explained by contact with domestic livestock. Some questions may be raised: Are game animals naturally suitable hosts? Do *Brucella* organisms cause abortion in any of the wild species?

Human brucellosis in Africa is widely documented. Bevan (1921-22) drew attention to the presence in Southern Rhodesia of cases of undulant fever. It appeared the Rhodesians became infected by drinking unpasteurised cows’ milk. In Nigeria *Brucella* infection and outbreaks in humans have been reported (Esuruoso and Hill, 1971; Alausa, 1978). Phippott and Auko (1972) working in Kenya, reported brucellosis in a family where a man, his son and daughter were victims. The family had shared their house at night with *Br. melitensis* infected goats. A report from Uganda suggests that brucellosis is an increasing public health hazard in that country (Ndyabahinduka, 1979). More extensive work on this subject in co-operation with the medical Departments of Health is required in every country.

It has been observed that goats experimentally infected with trypanosomiasis had suppressed antibody response to *Br. abortus* strain 19 (Shien, 1979), or *Br. melitensis* vaccination (Griffin *et al.*, 1980). A similar reaction has been reported in Trypanosoma-infected cattle vaccinated with *Br. abortus* strain 19 (Rurangirwa *et al.*, 1979).

The possible implications of these findings in the diagnosis of and immunization against brucellosis in Africa should not be overlooked, since trypanosomiasis is endemic in a significant part of Africa. It is therefore important to investigate whether administration of trypanocidal agents into animals before serological testing would lead to the detection of more *Brucella*-infected animals.

References


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Health Management of a Dairy Herd on the Jos Plateau (Nigeria)

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National Veterinary Research Institute, Vom, Nigeria

Summary
A close study of health problems of a mixed dairy herd comprising of Friesian, Fulani cattle and their crosses at Vom on the Jos Plateau was carried out over the past 17 years (1965-81). The animals were grazed in the fenced paddocks during the wet season and were stall fed during the dry season. Among diseases diagnosed were dermatophilosis (8.2%), infectious keratoconjunctivitis (15.7%), anaplasmosis (1.5%), babesiosis (3.9%), heartwater (1.2%), foot-and-mouth disease (3%), lumpy skin disease (2%), mastitis (9.6%), calf pneumonia (20.6%) calf diarrhoea (12.5%) etc. In addition the paper deals with the preventive vaccinations and treatments given to dairy cattle on the farm to avoid losses due to disease.

Introduction
According to FAO report (1980) the population of cattle in Nigeria stands at 12.3 million. The national herd is heterogeneous being comprised of nomadic, semi-nomadic, trade cattle and settled herds. All these groups are considered as beef cattle. A few thousand dairy cattle of Friesian, Brown Swiss and South Devon breeds have been imported for urban dairy programmes in the big towns. The quantity of milk produced by these animals is between 8 and 12 litres per animal per day, and they would better be called dual purpose animals. Health management programmes are difficult to implement where the herds are always on the move but comparatively easy for the settled herds. The cattle on the livestock farm at Vom are kept under close veterinary supervision and are provided with the best possible treatment and diagnostic service available in the country. Generally exotic breeds are highly susceptible to tropical diseases and more so the dairy breeds.

Dairy cattle are reared on a comparatively smaller area which favours higher challenge from parasitic and infectious diseases. Such cattle have to withstand many challenges including climatic stress. Fortunately Jos Plateau is blessed with a cool climate (21-26°C) and 1400 mm rain annually. A close study of health problems of the herd made over the past two decades may serve as a guideline for the dairy cattle on the Plateau and elsewhere and is reported herein.

Materials and Methods
The Vom herd consists of Friesians, White Fulani and their crosses. Wadara cattle were purchased in 1972 from Borno State but because of low productivity of those animals and their crosses they were disposed of in 1975. Friesian cattle were imported from England from 1962 to 1965 and 1974 to 1975. White Fulani cattle were purchased from Shika Farm, Zaria (Nigeria) as early as 1952. In 1980, a herd of 78 Friesian heifers and 2 bulls was imported for pure breeding programmes at the new site. Average milk yield of Friesian cows was a little less than 12 litres per cow per day. Fulani cows giving less than 500 litres of milk per lactation were considered uneconomical and were culled. All the animals were grazed on Rhodes grass, Vidan grass or Acha (Digitaria exilis) pastures. Fresh brewers spent grains were provided daily ad libitum to all animals. Concentrate feed supplement consisting of maize and groundnut cake was given to all the animals during the dry season (October to March) along with hay and maize or grass silage, but during the wet season (April to September) feed supplement was given only to those in milk at the rate of 1 kg per 2.5 kg of milk produced. Details of herd management are well documented elsewhere (Knudson and Sohael, 1970).

Health Problems Encountered
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<tr>
<td>Wounds &amp; injuries</td>
<td>12</td>
<td>6</td>
<td>6</td>
<td>19</td>
<td>5</td>
<td>6</td>
<td>3</td>
<td>3</td>
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<td>20</td>
<td>7</td>
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<td>27</td>
<td>10</td>
<td>23</td>
<td>19</td>
<td>33</td>
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<tr>
<td>Footrot &amp; lameness</td>
<td>8</td>
<td>3</td>
<td>3</td>
<td>11</td>
<td>10</td>
<td>15</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>7</td>
<td>14</td>
<td>10</td>
<td>16</td>
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<td>4</td>
<td>6</td>
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<tr>
<td>Bloat</td>
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<td></td>
<td></td>
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<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td>3</td>
<td>1</td>
<td>2</td>
<td>3</td>
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<tr>
<td>Otitis interna</td>
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</tbody>
</table>
Table 2: Statement of Stock on the Farm, Additions and Disposal for the Years 1977 - 81

<table>
<thead>
<tr>
<th>Year</th>
<th>No. of cattle in stock</th>
<th>Born</th>
<th>Purchased</th>
<th>Total</th>
<th>Still born</th>
<th>Given to lab.</th>
<th>Sold for breeding</th>
<th>Culled</th>
<th>Died</th>
<th>Total</th>
<th>Balance</th>
<th>Mortality (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1977</td>
<td>377</td>
<td>185</td>
<td>—</td>
<td>562</td>
<td>11</td>
<td>8</td>
<td>63</td>
<td>25</td>
<td>36</td>
<td>143</td>
<td>419</td>
<td>6.4</td>
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<tr>
<td>1978</td>
<td>419</td>
<td>198</td>
<td>—</td>
<td>617</td>
<td>13</td>
<td>21</td>
<td>29</td>
<td>47</td>
<td>90</td>
<td>200</td>
<td>417</td>
<td>14.6</td>
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<tr>
<td>1979</td>
<td>417</td>
<td>112</td>
<td>—</td>
<td>529</td>
<td>4</td>
<td>12</td>
<td>20</td>
<td>84</td>
<td>89</td>
<td>209</td>
<td>320</td>
<td>16.8</td>
</tr>
<tr>
<td>1980</td>
<td>320</td>
<td>154</td>
<td>—</td>
<td>474</td>
<td>8</td>
<td>10</td>
<td>53</td>
<td>42</td>
<td>70</td>
<td>183</td>
<td>291</td>
<td>14.8</td>
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<tr>
<td>1981</td>
<td>291</td>
<td>125</td>
<td>80</td>
<td>496</td>
<td>11</td>
<td>12</td>
<td>5</td>
<td>58</td>
<td>87</td>
<td>173</td>
<td>323</td>
<td>17.5</td>
</tr>
</tbody>
</table>

Table 3: Details of Cattle Culled and Died on the Farm During the Years 1977-81

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Culled due to:</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Old age</td>
<td>4</td>
<td>3</td>
<td>10</td>
<td>5</td>
<td>5</td>
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<tr>
<td>Unwanted cross-breds</td>
<td>12</td>
<td>32</td>
<td>52</td>
<td>25</td>
<td>24</td>
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<tr>
<td>Streptothricosis</td>
<td>1</td>
<td>2</td>
<td>8</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>Chronic lameness</td>
<td>4</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Miscellaneous</td>
<td>4</td>
<td>8</td>
<td>13</td>
<td>7</td>
<td>9</td>
</tr>
<tr>
<td>Total</td>
<td>25</td>
<td>47</td>
<td>84</td>
<td>42</td>
<td>59</td>
</tr>
</tbody>
</table>

| Died due to:     |      |      |      |      |      |
| Calf diarrhoea   | 12   | 30   | 29   | 23   | 18   |
| Calf pneumonia   | 10   | 31   | 25   | 13   | 10   |
| Tick fever       | 6    | 8    | 9    | 6    | 18   |
| Lumpy skin disease | —   | —    | 4    | —    | —    |
| Foot-and-mouth disease | —  | —    | —    | 4    | 5    |
| Cont. b. pleuropneumonia | —  | —    | —    | —    | 15   |
| Streptothricosis | 1   | 3    | 6    | 4    | 5    |
| Sudden deaths    | 1    | 3    | 2    | 12   | 12   |
| Miscellaneous    | 6    | 15   | 14   | 8    | 4    |
| Total            | 36   | 90   | 89   | 70   | 87   |

During the wet season (April to October) spraying of all cattle was done every week and in the dry season every 2 weeks. Since ticks acquire resistance to insecticide the brand of the chemical was changed every 6 months. Pfrizona (Pfizer Ltd) (1:300), Gammatox (Wellcome Ltd) (1:800), Delnav (Wellcome Ltd) (1:2,000) and Asuntol (Bayer Ltd) (1:1,000), were used in succession. The solution prepared was changed every 4 weeks during the wet season because of very heavy tick challenge and every 6 weeks during the dry season.

Cattle between 3 and 12 months of age were dewormed every month during the wet season and once every 2 months during the dry season. Cattle above 1 year of age were dewormed three times in a year; once in March again in July and then in October. Nilverm (ICI Ltd) was injected at the rate of 0.1ml/kg, Thibenzole (MSD) at the rate of 70 mg/kg, Banminth (Pfizer Ltd) at the rate of 0.1 g/kg, and Phenovis (ICI Ltd) at the rate of 0.2 g/kg bodyweight were given as a drench by rotation to prevent drug resistance by the adult worms and their larvae.

All cattle above 6 months of age were vaccinated annually against the following diseases.

<table>
<thead>
<tr>
<th>Month</th>
<th>Disease</th>
</tr>
</thead>
<tbody>
<tr>
<td>April</td>
<td>black-quarter</td>
</tr>
<tr>
<td>May</td>
<td>anthrax</td>
</tr>
<tr>
<td>July</td>
<td>haemorrhagic septicaemia</td>
</tr>
<tr>
<td>August</td>
<td>contagious bovine pleuropneumonia</td>
</tr>
<tr>
<td>November</td>
<td>rinderpest</td>
</tr>
<tr>
<td>December</td>
<td>foot-and-mouth disease</td>
</tr>
</tbody>
</table>

Preventive Treatments

The following treatments were given regularly to all cattle over 3 months of age.

contagious diseases, infectious diseases, calf diseases, reproductive diseases and surgical diseases. Animals unfit for breeding purposes and those unable to move due to debility, lameness, incurable disease or blindness were culled. Details are provided in Tables 2 and 3.
(iv) Cases suspected of any contagious disease were promptly isolated and treated with appropriate antibiotic. Any case of pyrexia of unknown origin (POU) during the wet season was suspected to be due to piroplasmosis and animals were placed under observation immediately. Those with fever were given a combination of Berenil (1 g/300kg bodyweight) and 30 ml solution of oxytetracycline (Terramycin, Pfizer Ltd) or any other available tetracycline. Examination of blood smears from all such cattle was done for blood parasites. A few cases, 10-20% of those affected, had demonstrable piroplasms, but trypanosomes were found only in a solitary case.

(v) All animals of breeding age were annually screened for brucellosis by serum agglutination test and by milk test every 2 years.

(vi) To prevent mastitis, as soon as cows become dry, intramammary injection of crystalline penicillin (200,000 IU) and streptomycin (0.5 g) per quarter was administered. For the cows in milk, udder hygiene was practiced by cleaning with a towel soaked in a disinfectant (freshly prepared 0.5% tropical chloride of lime solution in water), and the teat cups were dipped in similar solutions. Strip-cup test was applied to all the quarters before each milking. Infected cows were milked at the end and milk utensils sterilised after use.

(vii) Tuberculin testing: a single intradermal test with mammalian and avian tuberculin was applied to all animals above 6 months of age every alternate year.

Results and Discussion

Taking into account the average strength of total livestock on the farm, the percentage incidence of disease was calculated for the last 5 years and is given at the end of Table 1. The diseases found to be of economic significance were streptococcosis (8.2%), infectious keratoconjunctivitis (15.7%), tick-borne diseases (6.6%), calf scours (20.6%) etc. This incidence of disease may appear higher in tropical than in temperate climates wherefrom these exotic animals were imported. Similar observations were made by Okao and Oteng (1973) in Uganda. The cooler climate and freedom from trypanosomiasis on the Jos Plateau is ideal for exotic dairy cattle to thrive. Despite the prevalence of disease, the dairy farm between 1977 and 1981 produced 1,295,838 litres of milk, supplied 170 breeding heifers, provided 53 calves for cell culture for vaccine production and research, and 256 culled animals provided meat for the factory. Cost-benefit analysis was difficult since in addition to production of milk, meat and heifers for breeding purposes etc. the farm also served as a demonstration unit for animal husbandry students and farmers.

I. Contagious Diseases

1. Rinderpest: No outbreak of rinderpest was observed through the years in the Vom dairy herd although Johnson (1958) reported it in the experimental laboratory cattle and sheep at Vom. All cattle above 6 months of age are vaccinated against rinderpest annually according to State Ministry's circular. Since rinderpest recurred in Nigeria in 1980 and later, it is worthwhile to protect all cattle by revaccination (Nawathe and Lamorde, 1982).

2. Foot-and-mouth disease: Two outbreaks due to SATI type virus occurred in 1972 (Smith, 1976) and in 1980 (Table 1). Since infected animals were provided food and water on the spot the mortality was insignificant. Mortality would certainly be pronounced if animals were made to trek down for water and for grazing. However there was considerable loss in milk production and six calves died from this disease during the 1980 outbreak.

Between 1973 and 1975 annual vaccination was undertaken with the homologous vaccine supplied by AVRI, Pirbright, U.K. (Mowat et al., 1975). Since then routine vaccination was not possible due to the non-availability of the vaccine. The commercial vaccines do not afford protection against infection with local strains (Nawathe and Majiyagbe, 1981). Development of homologous vaccine for prevention of the disease is the only solution in the present day.

3. Lumpy skin disease: Outbreaks occurred in 1974 and again in 1979 (Nawathe et al.,
1978; Nawathe et al., 1981). It is a benign disease but in association with piroplasmosis it has caused some mortality. There is no treatment available in the country either preventive or curative against this disease as yet.

4. Contagious bovine pleuropneumonia: During the wet season of 1981, 15 deaths occurred due to this disease and two suspected carriers were culled. All adult cattle were screened by complement fixation test for chronic carriers, and revaccinated. No reason of vaccine-break or vaccination-break was traced. One must be vigilant to stop such episodes from recurring.

5. Streptothricosis or dermatophilosis: The incidence of this disease in recent years has unfortunately been on the increase. During the outbreak in 1981, 42 cattle were affected of which six heifers died, and 19 others were culled. On an average 20 animals had to be culled annually because they did not respond to treatment. Macadam (1964) stated that bites from ectoparasites set up lesions of this disease. Gbodi and Ndife (1981) found that zinc supplementation did not have any curative effect but multiple doses of penicillin and streptomycin were most effective followed by long-acting oxytetracycline (Terramycin L-A, Pfizer Ltd).

6. Infectious keratoconjunctivitis (IKC): The incidence of infectious keratoconjunctivitis (IKC) was alarming during the dry season each year and is probably associated with deficiency of vitamin 'A'. Friesian calves suffered most as compared to their crosses with Fulani or pure Fulani calves. Although Morexella bovis was consistently isolated its pathogenicity could not be proved by instillation of cultures into the eyes of susceptible calves (Griffin et al., 1965). No virus was isolated in cell cultures or eggs. Thelazia spp. infection was diagnosed in two cases (Ikeme, 1967). The disease caused reduction in growth rate and affected calves weighed 15-20kg less than unaffected ones at 6 months age.

The treatment of IKC consisted of injections of vitamin A, D and E intramuscularly and eye dressing with oxytetracycline (Terramycin, Pfizer Ltd) eye ointment. Other dressings like, sulfaethiazole 5%, Neobiotic eye drops (UpJohn Ltd) or Panalog (Squibb Ltd) did not give better results. Recovery occurred in 2-4 weeks time.

A very few cases, which did not respond to treatment, became blind and had to be culled.

II. Infectious Diseases

1. Trypanosomiasis: Since Jos Plateau is a tsetse-free area there were no cases of trypanosomiasis observed. During 1981 a solitary case in a Friesian heifer was reported. It indicates the inherent danger of spread by mechanical carriers in the absence of tsetse fly, as happened in 1947 (Anon, 1948). Joshua and Kayit (1982) have observed trypanosomes in blood smears of a few local cattle on the Jos Plateau.

2. Piroplasmosis (babesiosis) and anaplasmosis: Despite regular spraying, cases of babesiosis and anaplasmosis have occurred during the wet season. Parasites were found in the blood smears of a few animals, but many more were running temperatures and showed symptoms suggestive of these infections. All those with pyrexia were given treatment with Berenil (Hoechst Ltd) and Terramycin (Pfizer Ltd) by injection.

During 1980, sprayrace could not be installed at the new farm before the animals arrived from overseas with the result that some 10 cows died and 13 aborted due to anaplasmosis and babesiosis within 2 weeks. Others were saved by treatment with Imidocarb (Imizol, Wellcome Ltd), at the rate of 2.5 ml/100 kg bodyweight (Ajai et al., 1981). Anaplasmosis and babesiosis are by far the most feared diseases despite regular treatment with insecticides because exotic breeds are highly susceptible and are subjected to constant and heavy challenge especially during the wet season. There is a case for resorting to vaccination against these diseases suggested by Leeflang and Schillhorn Van Veen (1971), in addition to the use of insecticides, or to chemoprophylaxis with Imidocarb in the wet season.

3. Miscellaneous diseases: During the wet season sometimes cases of coccidiosis due to Eimeria zurnii were diagnosed in calves. Those clinically sick were treated with sulphadimidine solution or tablets in curative doses and all other calves in the group given injection of sulphadimidine as preventive.

Sudden deaths were due to heartwater and some others were due to haemorrhagic enteritis, colisepticaemia and enterotoxaemia. Since animals were found dead in the paddocks no treatment was possible. Causal
agents isolated from cases of sudden death were *Corynebacterium pyogenes*, *Salmonella enteritidis*, *Pseudomonas aeruginosa*, *Escherichia coli*, *Proteus retgeri* and *Klebsiella pneumoniae*. Some cases of sudden death were due to contagious bovine pleuropneumonia.

Tuberculin testing occasionally yielded one or two doubtful cases but no lesions were seen on post mortem and cultural examinations were negative. These cases could be false positive as suggested by Alhaji (1978).

Serological surveys conducted on the farm indicated widespread incidence of Parainfluenza 3 (Taylor et al., 1975), virus diarrhoea (Okeke, 1976) and blue tongue (Taylor and MacCauseland, 1976). A few cases of bovine popular stomatitis in calves (Plowright and Ferris, 1959) and a case of pseudocowpox were observed (Asagba, 1982). No clinical significance was attached to these infections. Two cows were positive to enzootic bovine leucosis in agar gel precipitation test and were culled (Adu and Olson, 1981).

Very close to the Vom herd, two serious diseases were noticed in local Fulani herds. In a herd of 70 cattle, 15 calves died due to parasitic bronchitis caused by *Dictyocaulus viviparus* (Fabiyi, 1982). In another herd, sheep-associated malignant catarrhal fever caused 43 deaths out of 172 heads (Pullen and Rowland, 1979). The disease spread stopped as soon as the owner got rid of his flock of sheep.

**III. Calf Diseases**

Calf mortality constituted 90% of total mortality and was crucial between the 1st and 2nd month of age and calves born at the beginning of the wet season fared better. It was not possible to plan calvings in the old farm, though the majority of cows calved at the beginning of the wet season. In the new farm since all heifers-in-calf arrived at one time, their subsequent calvings could be controlled to result in calving at the desired time.

Whenever outbreaks of infectious disease occurred on the farm, calves suffered most. Foot-and-mouth disease, lumpy skin disease and streptothricosis are benign in adults but caused serious illness and deaths in calves. Infectious keratoconjunctivitis was a perennial problem in the calves although most of them finally recovered.

Ibeawuchi *et al.* (1981) noted that out of 791 calves born at Vom between 1976 and 1981 one-third of them died due to disease, the most important being: calf scours (19%), calf pneumonia (16%) and streptothricosis (11%). In a Brown Swiss herd in a humid zone (Ibadan), Otesile *et al.* (1982) found in addition, septicaemia (12%) and omphalitis (7.9%) responsible for calf mortality.

Only bacterial and parasitic cases of calf disease were investigated. Calf diarrhoea was due to *Salmonella typhimurium*, *S. dubin*, *S. enteriditis*, enteropathogenic *Escherichia coli*, *Klebsiella pneumoniae* and *Pseudomonas aeruginosa*. Calf pneumonia was due to *Pasteurella haemolytica*, *P. pneumotropica*, *Klebsiella pneumoniae*, *Streptococcus pyogenes*, *S. faecalis*, *Alkaligenes faecalis*, *Staphylococcus aureus*, *S. albus*, *Escherichia coli*, *Citrobacter spp.*, *Pseudomonas aeruginosa* and *Corynebacterium pyogenes*. Massive doses of broad spectrum antibiotics and sulfadimidine helped only in the initial stages of calf diarrhoea or pneumonia. Parasitic gastroenteritis was sometimes responsible for calf diarrhoea and unthriftness. The causal agents included species of *Haemonchus*, *Cooperia*, *Oesophagostomum* and *Bunnostrongylus*. The worm burden was high during the wet season. Anthelmintics (nematocides especially) had to be used in rotation to be more effective.

**IV. Reproductive Diseases**

Of the reproductive diseases, dystocia, retention of placenta and metritis were treated with massive doses of antibiotics after necessary surgery. For mastitis, prophylactic treatment consisted of infusion of each quarter with 200,000 IU of crystalline penicillin and 0.5 g of streptomycin given as a routine; even then some cases needed intramammary injection of antibiotic solutions. Occasionally chronic cases of mastitis and metritis terminated in septicaemia and death. A few cows with incurable chronic mastitis had to be culled. The organisms commonly isolated from cases of mastitis were *Streptococcus* spp., *Staphylococcus aureus*, *Escherichia coli* and *Klebsiella pneumoniae* in order of prevalence. Since the introduction of the California mastitis test many cases of subclinical mastitis were detected and subsequently treated. The milk from such cows was boiled and fed to
young calves by bucket. In the recent past, increased incidence of retention of placenta accounted for a proportional increase in the cases of metritis. Pyogenic organisms like *Streptococci, Staphylococci, Corynebacteria* and *Escherichia coli* were isolated. A few chronic cases died from septicaemia while those resistant to antibiotic treatment had to be culled.

Cases of listeriosis were suspected and treated with antibiotics without much success. Organisms (*Listeria monocytogenes*) were isolated from an aborted foetus during the outbreak of lumpy skin disease (Nawathe *et al.*, 1981). The herd was serologically negative for brucellosis. Cases of abortions were also negative for vibriosis, trichomoniasis and to any viral aetiology.

**V. Surgical Diseases**

Wounds, injuries, bloat and otitis interna were of least significance amongst surgical diseases. Footrot and lameness due to sprained fetlocks or badly-tended hooves was of great concern since such animals could not go out for grazing. They lost condition and some chronic ones had to be culled.

**Acknowledgement**

The Authors wish to thank the Director of the Institute for permission to publish this paper, and numerous other workers who helped in the diagnosis and treatment of the sick cattle.

**References**


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Seasonal Variation of Cattle Ticks in a Subhumid Area of Morocco

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Summary

From May 1979 to April 1980, once or twice a month, ticks were collected from a sample of 32 oxen of different ages and breeds and maintained under variable conditions. Three species of ticks were found: *Rhipicephalus turanicus* (18.8%), *Hyalomma lusitacum* (38.9%) and *H. marginatum* (42.3%). Of the 32 animals sampled, those aged over one year were found to be more infested with ticks than those aged below one year. Also, more ticks were found on those managed in forest areas than on those raised on natural grass lands. All three ixodidae species found reached the peak of their activity in spring and left the animals for 2-3 months during winter.

Introduction

Ticks and tick-borne diseases are quite common in Morocco. The FAO Expert Consultations held in 1975 and in 1977 laid stress on the imperative need to study the biology, the ecology and the dynamics of tick populations as a precondition to any rational control of ticks and tick-borne diseases.

With the exception of some collections set apart mainly for final studies (Morel and Vassiliades, 1962; Bailly - Choumara *et al.*, 1974) Morocco has no data on the population dynamics and seasonal activity of cattle ticks. This research work which concerned the activity of cattle ticks throughout the year, was aimed at determining the impact of host age, breeding type, herd management and the seasonal effect on cattle infestation by ticks.

Materials and Methods

The study took place at the animal husbandry station at El Koudia 30 km West of Rabat, about 10 km off the Atlantic Coast. The climate of the area is mediterranean, ranging between humid and subhumid with a mean rainfall of 500 mm. The rainy season, ranging from October to April — May is followed by a dry period. The mean maximum temperature of the hottest month of the year (generally August) is 28°C and that of the coldest month (generally January) 7°C.

The Animals

Two types of cattle are raised on the farm: Local breeds chiefly the oulmes breed and cross breed (local breed x Piebald Friesian).

Herd Management

The cattle population of the farm is subdivided into two groups according to system of herd management. One group is allowed to pasture in the forest area from November to June then on stubble fields for the rest of the year. The other group is never allowed to pasture in the forest area but from November to June it is put on natural grassland then on the stubble fields. The second group of cattle is given feed supplements during periods of feed stringency.

Tick Collection

Between May 1979 and April 1980, once or twice a month, ticks were collected alive from 32 oxen divided into eight groups as shown in Table 1. These individuals were randomly selected from each type of breeding. The individuals selected for a sampling were separated from the future samples. The ticks were preserved in alcohol at 70% then identified in the laboratory. No acaricide was applied during the period of the study.

<table>
<thead>
<tr>
<th>Table 1: Plan for Tick Collection in Cattle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Herd management</td>
</tr>
<tr>
<td>----------------</td>
</tr>
<tr>
<td>Pasturage in forest area (type I)</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Pasturage outside forest area (type II)</td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>
Results

A total of 686 ticks were collected during the study, of this 18.8% were represented by *Rhipicephalus turanicus*, 38.9% by *Hyalomma lusitanicum* (confirmed by Dr. P.C. Morel of the Institut d’Elevage et de Medecine Veterinaire des pays Tropicaux, IEMVT, France) and 42.3% by *H. marginatum* (confirmed by Dr. H. Hoogstraal of Nemru, Cairo).

Age Effect

Of the population collected, only 17-19% came from the young animals. Irrespective of the type of cattle, ticks were found to be more abundant in cattle aged over one year. (Table 2).

| Table 2: Effect of Cattle Age on Infestation by Ticks |
|---|---|---|---|
| Month | Mean No. of ticks per animal | Animals below 1 year | Animals over 1 year |
| May | 1.25 | 5.75 | |
| June | 0.31 | 6.00 | |
| July | 0.25 | 3.00 | |
| August | 1.00 | 2.75 | |
| September | 0.25 | 0.75 | |
| October | 0.13 | 1.75 | |
| November | 0.13 | 0.88 | |
| December | 0 | 2.13 | |
| January | 0 | 0.06 | |
| February | 0 | 0 | |
| March | 0 | 0 | |
| April | 0.06 | 3 | |

Effect of Cattle Type

Of the 686 ticks examined, 75% were collected on animals of cattle type one and 25% on those of type two. Regularly throughout the period of the study, we significantly found more ticks on cattle pasturing in the forest area, no matter the breed of the host considered (Table 3).

Breed Effect

No significant difference was found with regard to the rate of cattle infestation by ticks in subjects of the same age and of the same system of breeding (Table 3).

| Table 3: Effect of Herd Management on Cattle Infestation by Ticks |
|---|---|---|---|
| Month | Animals pasturing in forest zone (type I) | Animals pasturing outside forest zone (type II) |
| | Local breed | Cross breed | Mean | Local breed | Cross breed | Mean |
| May | 6.06 | 4.13 | 5.09 | 0.88 | 1 | 0.94 |
| June | 5.13 | 4.75 | 4.94 | 0.94 | 1.5 | 1.22 |
| July | 3.12 | 2.0 | 2.56 | 1.19 | 0.5 | 0.85 |
| August | — | — | — | 1.38 | 1.12 | 1.25 |
| September | 0.5 | 2.13 | 1.31 | — | — | — |
| October | 1.44 | 1.06 | 1.25 | 0.44 | 0.68 | 0.56 |
| November | 1.5 | 1.38 | 1.44 | 0.5 | 0.13 | 0.31 |
| December | 1.5 | 1.25 | 1.38 | 0.63 | 0.25 | 0.44 |
| January | 0.06 | 0.31 | 0.19 | 0 | 0.06 | 0.03 |
| February | 0 | 0 | 0 | 0 | 0 | 0 |
| March | 1.19 | 0.13 | 1.26 | 0 | 0 | 0 |
| April | 4.75 | 9.5 | 7.13 | 0.5 | 0 | 0.25 |

Location of Ticks

The species *Hyalomma* spp. and *R. turanicus* have some preferential places of anchorage (Table 4) this is why *R. turanicus* is found mostly near the ears whereas *Hyalomma* spp. sticks in 59.2% of cases near the mammary glands (or testicles) and 33.2% on the inner side of the thighs.

| Table 4: Places where Ticks Fix Themselves on the Animal Body |
|---|---|---|
| | Rhipicephalus turanicus (%) | Hyalomma spp. (%) |
| Ear | 80 | 3.3 |
| Perineum | 6 | 33.2 |
| Base of tail | 5.5 | 4.3 |
| Mammary glands or testicles | 8.5 | 59.2 |

Seasonal Variation

*R. turanicus*: The abundance and seasonal activity of *R. turanicus* depends on the system of herd management. In cattle type one (raised in the forest area) the level of infestation was higher than in cattle type two (Fig. 1).
Ticks were present during the whole year except during the months of February and March for cattle type one and during the months ranging from January to April for cattle type two.

In the first herd infestation reached an initial peak in the month of May and a second in December. The second peak was due to the presence of nymphs feeding on the hosts. The adult ticks were absent from December to March.

In cattle type two, the population of ticks was lower than within cattle type one, thus the seasonal variations were less apparent (Fig. 1).

**H. marginatum:** This species represents 39% of the entire number of ticks collected in cattle type one and 51% in type two. In the first group, the peak of infestation was observed in the month of April-May (Fig. 2). Type two had a less parasite burden, however during spring and summer the level of infestation was higher compared to Autumn and similarly ticks of this species were absent in winter.

**H. lusitanicum:** It forms 40.2% of the total population of ticks in cattle type 1 and 34.9% in cattle type two. As in the case of the other two species, animals raised in the forest area were more infested by *H. lusitanicum*. The peak of infestation by this species was observed in April - May - June whereas the same species was absent in February - March (Fig. 3).

**Discussion**

As observed in the sheep raised on the same farm (Ouhelli *et al.*, 1982) in the cattle, age appears to have an effect on the intensity of infestation by ticks. On the other hand, the breed effect, in our case does not interfere with this infestation. It must be recalled that this factor plays a role in cattle genetically quite distinct. It has been reported, in the case of infestation by *Boophilus microplus*, that the
Jersey breed and the cross breeds (*Bos indicus x Bos taurus*) have the same resistance to this species, whereas *Bos indicus*, *Bos taurus x Bos indicus* and *Bos taurus* show successively infestation indices of 1.3 and 15 (FAO, 1977).

It seems that both breeds involved in this study are not sufficiently distinct to cause the influence of this factor to appear. Contrary to the observation made in cattle, the two breeds observed in the sheep (Sardi and Timahdit) in the same farm show a significant difference in the level of infestation by *R. turanicus* (Ouhelli et al., 1982).

**Herd Management Effect**

Cattle pasturing in forest area have invariably a higher degree of infestation than those pasturing outside the forest area. Two main factors could explain this difference. The first is ecological: In the forest area the free stases have more chances of development and survival than on the treeless and bushless pastures; the absence of protection places these ticks directly under the adverse effect of the heat and the drought. The second factor is associated with the biology of the three species found: In the forest area, we noted the presence of wild rodents which are the preferential hosts of the immature forms of *R. turanicus* (Morel and Vassiliades, 1962) and of the species *Hyalomma* (Hoogstraal, 1956), which constitutes an additional source of cattle infestation.

**Location of Ticks on the Animal**

Although in sheep and cattle, *R. turanicus* sticks at the level of ear of the host, and *Hyalomma* on the mammary glands (testicles) and the inner side of the thighs, at the peak of infestation ticks are found on other parts of the body such as the perineum, the dewlap and the neck.

**Seasonal Dynamics of Ticks**

In the case of the three species found, the animals are free from ticks during winter and appear to have reached an infestation peak in Spring. This seasonal activity seem to be associated with the conditions of the environment; because of the low temperatures in autumn and winter, the development of immature stases appear to slow down and could extend over some months.

It is only when there was a rise in temperature associated with a suitable humidity that the nymphs acquired the adult form in spring. During the hot and dry months of the year, the climatic conditions become unfavourable for the development of the ticks whereas the parasitic burden due to the ticks decreases progressively towards annulation by the end of autumn.

The observations concerning *H. lusitanicum* differ from those reported by Blanc and Bruneau (1956) who found the adult of this species on the hosts in each month of the year. The adult *R. turanicus* follows the same type of activity as *Hyalomma*, but during autumn and the beginning of winter, an important population of nymphs was found in the cattle managed in the forest area. It is known that *R. turanicus* develops in the immature stases on rodents, and the adults on ungulates (Morel and Vassiliades, 1962). However this observation shows that the nymphs can equally stick on cattle. On the other hand we found no nymph of this species on the sheep of the same farm, observed at the same time as the cattle, although *R. turanicus* at the adult stage is found in larger numbers in these small ruminants.

Cattle type two which do not pasture in the forest area are not infested by the *R. turanicus* nymphs. It would seem that the nymphs are in larger numbers in the forest inhabited by wild rodents which are the preferential hosts of the immature stases and that when the opportunity presents itself, they turn towards the cattle. This aspect of the population dynamics deserves an in-depth study.

**References**


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Pathogenesis of Haemorrhages in *Trypanosoma vivax*
Infection in Cattle

1. Disseminated Intravascular Coagulation

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Summary

A study was carried out to determine the pathogenesis of haemorrhages in *Trypanosoma vivax* infection in cattle. Eight animals were infected with a haemorrhagic strain of *T. vivax* isolated from a field outbreak of the disease at the Coast Province of Kenya. Three animals served as controls. Severe thrombocytopenia developed 20 days post infection and persisted until the end of the experimental period of 100 days. Coagulation studies carried out revealed prolonged prothrombin and partial thromboplastin times. The mean plasma fibrinogen levels in both infected and control animals were within the recommended normal limits, but the plasma protamine para-coagulation tests revealed the presence of fibrin monomers in plasma from all the eight infected animals. It was concluded that the haemorrhages observed in cattle infected with haemorrhagic *T. vivax* strains could be due to disseminated intravascular coagulation and fibrinolysis syndrome.

Introduction

*Trypanosoma vivax* causes major losses in cattle in West Africa (Hoare, 1972); whereas in East Africa the disease is usually characterized by low mortality and low morbidity (Hornby, 1929). Recently however, there have been outbreaks of a haemorrhagic disease caused by *T. vivax* in Kenya. The purpose of this work, therefore, was to study the pathophysiologic mechanisms that underlie the haemorrhages in cattle infected with a haemorrhagic strain of *T. vivax*.

Materials and Methods

**Experimental cattle**

A total of 11 steers aged 1-1½ years were used in this experiment. The breeds of these animals were Ayrshire/Sahiwal crosses and Ayrshire/Hereford crosses. During the experimental period, animals were housed in a medium sized fly-proof barn containing eight pens. Two animals were housed in each pen and had no contact with the animals in the adjacent pens. A bale of hay was provided to every two animals per day. This was supplemented with 3 kg of ranch cubes (supplied by Unga Ltd, Kenya) per animal per day. The animals had free access to mineral salt lick (supplied by Pfizer Laboratories Ltd, Nairobi) and water.

**The Parasite and Infection**

The *T. vivax* parasites used were supplied by Dr. B. Wellde, Veterinary Research Laboratory, Kabete. This was a stabilate made from a field outbreak of haemorrhagic *T. vivax* infection in Msambweni region, Kwale District, Coast Province, Kenya. Each test animal was inoculated intravenously (i.v.) with $1.0 \times 10^5$ trypanosomes from the first parasitaemia of a donor calf. The parasites were suspended in phosphate saline glucose pH 8.0.

**Collection of Blood Samples**

Blood for smears and thrombocyte counts was obtained from the jugular vein in disodium ethylenediaminetetraacetic acid (EDTA) three times per week. Blood for coagulation studies was mixed with 3.8% sodium citrate solution (9:1) and kept in ice bath before and after refrigerated centrifugation for 20 min at 3,000 g. Plasma was then separated from blood and kept in the freezer at 80°F until the end of the experiment when coagulation studies were undertaken.

**Counting of Trypanosomes**

Parasitaemia was assessed by microscopic examination of thin Giemsa stained smears. This was done by counting both trypanosomes and white blood cells (Wbc) in the smears, either in 400 fields or in 100 oil
immersion fields if there were more trypanosomes than white blood cells. The trypanosome:leucocyte ratio was then multiplied by the respective total leucocyte count to obtain an estimate of the trypanosome concentration in the peripheral blood. The parasitaemia count per microlitre (μl) of blood was calculated as follows:

\[
\text{Trypanosomes} = \frac{\text{Total Wbc} \times \text{trypanosomes}}{400 \text{ or } 100 \text{ fields}}
\]

\[
\text{Wbc}/400 \text{ or } 100 \text{ fields}
\]

**Haematology**

Determination of erythrocyte counts (Rbc), white blood cells (Wbc), packed cell volume (PCV) and mean cell volume (MCV) was done by using an automatic electronic counter machine (Counter Electronics Inc., Hialeach, Florida. Model P64). Haemoglobin concentration (Hb) was estimated through a haemoglobinometer attached to the main counter machine indicated above.

Differential cell counts were determined on 200 leucocytes per Giemsa stained peripheral blood smear.

**Platelet Counts**

Platelet numbers were determined by phase microscopy according to the method of Brecher and Cronkite (1950).

**Coagulation Studies**

Prothrombin time was determined according to the method of Quick et al. (1963) while the method of Schalm et al. (1975) was used for determining partial thromboplastin time. Protamine paracoagulation test for fibrin monomer and fibrin split products was performed according to the method described by Seaman (1970). Plasma fibrinogen levels were determined using the method described by Ratnoff et al. (1951).

**Results**

This study was carried out for a period of 100 days. Out of the eight infected animals, two animals died from acute trypanosomiasis with severe enteric and subcutaneous haemorrhages and massive haemorrhages in parenchymatous organs. Three animals died from subacute trypanosomiasis with mild haemorrhages in various tissues and organs. Two animals developed chronic trypanosomiasis and died about 90 days post infection. One animal developed chronic trypanosomiasis and survived the infection but was subsequently electrocuted 100 days post infection.

**Parasitaemia**

Trypanosomes were first detected in the peripheral blood circulation of experimental cattle 6 days post infection. The highest mean number of trypanosomes (peak) was observed on day 20. After this day, there was inconsistent fluctuation of parasitaemia in individual animals. The mean daily numbers of trypanosomes per microlitre which are shown in Figure 1 indicate that there were three parasitaemic peaks on days 20, 35 and 90. There was an inverse relationship between parasitaemia (Fig. 1) and thrombocytopenia (Fig. 7). Routine examination of lymph node biopsies revealed the presence of trypanosomes usually at a time when parasitaemia was high and when it was possible to detect trypanosomes in peripheral blood circulation. Trypanosomes were usually not detected in lymph node smears or peripheral blood circulation prior to death or at the time of death.

![Figure 1: Mean daily numbers of trypanosomes (10^7/μl).](image-url)
**Red Blood Cell Concentrations**

The results of the changes in the red blood cell concentrations are shown in Fig. 2. There was a steady reduction in the number of red blood cells starting from 10 days post infection. The low cell counts continued until 30 days post infection when it stabilized for a while before hitting a minimum cell count of 2.4 x 10^6 on day 60 post infection. This low red blood cell concentration was maintained for 20 days before starting to rise again 80 days post infection.

![Graph showing red blood cell counts post infection](image)

**Figure 2:** Mean concentrations of red blood cells in *T. vivax* infected cattle.

**Red Blood Cell Mean Corpuscular Volumes**

The means of red blood cell mean corpuscular volumes are shown in Fig. 3. There was a slight increase in the red blood cell mean corpuscular volumes 30 days post infection. This increase was gradually maintained until a peak value of 80 was attained at about 60 days post infection. The MCV values remained high for a period of about 20 days. On day 90 the MCV values had come down to 53.7, which is the upper limit of the normal.

![Graph showing MCV post infection](image)

**Figure 3:** Red blood cell mean corpuscular volumes of *T. vivax* infected cattle.

**Haemoglobin (Hb) Concentrations**

There was moderate fluctuation in haemoglobin concentration in *T. vivax* infected steers. The haemoglobin concentrations reduced from 10g/100 ml on day 10 post infection as shown in Fig. 4 and by day 30 the value dropped to 4.7g/100 ml. The lowest Hb value (3.94g/100 ml) was recorded 60 days post infection after which period, the...
values remained at the level of 5.77g/100 ml until the end of the experiment. There was little fluctuation in the values of haemoglobin concentrations in control animals where the lowest value recorded (9.70) was on day 60 and was maintained at this level until the end of the experiment.

**Packed Cell Volume**

The mean PCV values were significantly below initial and control values after day 12 in infected cattle. There was moderate fluctuation in PCV values in control cattle, but these values were within the upper normal level. The changes in the mean PCV are shown in Figure 5. The mean PCV value in the *T. vivax* infected cattle declined to its minimum value of 12.4% on day 60. Changes in PCV closely paralleled changes in haemoglobin concentrations (Fig. 4) and red blood cell concentration (Fig. 3).

![Graph of packed cell volume](image)

**Figure 5: Mean packed cell volume (PCV) of *T. vivax* infected cattle.**

**White Blood Cell Counts**

There was significant reduction in the mean Wbc counts on day 10 as shown in Figure 6. There were two peaks of mean Wbc counts which were observed on day 40 when 22.73 x 10^1/mm^3 cell count was recorded and on day 70 when 17.07 x 10^1/mm^3 cell count was recorded. There was an inverse relationship between the white blood cell counts and parasitaemia. Leucocytosis was observed (Fig. 6) on day 40 and also observed on day 70 at the time when parasitaemia was lowest (Fig. 1). The differential cell counts, however, showed that the leucocytosis was not due to an increase of any particular cell type. There were no significant changes observed in the mean values of Wbc counts in control cattle.

![Graph of white blood cell counts](image)

**Figure 6: Mean white blood cell counts of *T. vivax* infected cattle.**

**Platelet Counts**

The mean platelet concentrations reduced considerably from the normal value of 608,000/μl on day 1 (Fig. 7) to a low value of 153,000/μl by day 10 and 50,880/μl by day 20. After this period there was great fluctuation in platelet counts in each individual animal until on day 90 when another low peak was recorded (Fig. 7). The thrombocytopenia was inversely related to the parasitaemia. The two thrombocytopenic peaks which were observed on day 20 and day 90 coincide with high parasitaemia
peaks on those days. The lowest thrombocytopenic peak (Fig. 7) of 33,670/μl was recorded on day 40 at a time when parasitaemia was also lowest. However, this thrombocytopenic peak was preceded by a high parasitaemic peak which was observed on day 35 (Fig. 1). There was clumping of platelets which was observed at different times in individual animals. The clumping of platelets was usually associated with a high parasitaemia in each animal.

![Graph showing platelet concentration](image1)

**Figure 7: Mean platelet concentration in T. vivax infected cattle.**

**Prothrombin Time**

The results of the prothrombin test showed that there was no significant difference between the two groups of animals during the first 20 days post infection. Thereafter, the mean prothrombin time of infected cattle was increased from 47 seconds to 62 seconds. From day 30 up to day 90 there was fluctuation of the mean prothrombin value of infected cattle which ranged from 53 to 59 seconds. There was no significant change in the values of the mean prothrombin time in control cattle.

**Partial Thromboplastin Time (PTT)**

The results of partial thromboplastin times were consistent with those of prothrombin times. There was no significant difference between the two groups of animals for the first 15 days post infection. The mean PTT value increased from 49 seconds on day 1 to 69 seconds on day 20 (Fig. 8) and thereafter fluctuated between 58 and 62 seconds. There was no significant change in the mean PTT values of control cattle which ranged from 53 to 60 seconds.

![Graph showing partial thromboplastin time](image2)

**Figure 8: Mean partial thromboplastin time in T. vivax infected cattle.**

**Fibrinogen Concentrations**

Results of fibrinogen concentrations indicated that although the means of plasma fibrinogen levels of infected cattle were slightly elevated on day 20, there was no significant difference between the mean values of both groups of animals. The mean plasma fibrinogen levels in both infected and control animals were within the recommended normal limits.

**Plasma Protamine Paracoagulation Tests**

The results of plasma protamine paracoagulation test are shown in Table 1. There was a direct relationship between the amounts of fibrinogen degradation products detected and the clinical severity of the disease. Plasma samples taken from the five animals which died in the acute phase were strongly positive for fibrin monomers. Plasma samples from the two animals that
Table 1: Results of Plasma Paracoagulation Tests of *T. vivax* Infected Animals

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Died in the chronic phase and one animal that survived the infection showed a weak positive reaction for fibrin monomers. Plasma samples from control animals were negative.

**Discussion**

Disseminated intravascular coagulation (DIC) and fibrinolysis syndrome is characterized by a tendency to coagulation where in depletion of clotting factors and excessive fibrinolysis results in a paradoxic clotting inadequacy (McKay, 1965). It may be caused by antigen-antibody complexes, tissue damage, intravascular haemolysis, endotoxin and systemic hypersensitivity or by extensive diffuse endothelial damage (Thomson, 1978). As fibrin, fibrinogen and factors V (proaccelerin, labile factor) and VIII (antihaemophilic factor) are all broken down there is decreased opportunity for further clotting to take place. This may then lead to an animal bleeding to death.

In the present study cattle infected with *T. vivax* developed severe thrombocytopaenia, prolonged prothrombin and partial thromboplastin times and had circulating fibrin monomers as revealed by the protamine sulphate paracoagulation test. These findings indicate that the *T. vivax* stock used in this study induced the development of a disseminated intravascular coagulation and fibrinolysis syndrome in the infected animals.

Although accurate quantitative estimation of fibrinogen degradation products (FDPs) was not performed in this work, the protamine sulphate paracoagulation test clearly showed that there was direct relationship between the amounts (levels) of FDPs and the clinical severity of the disease. Animals which died from acute and subacute trypanosomiasis had high levels of FDPs whereas animals which died from chronic trypanosomiasis had either very low levels of FDPs or in some cases, had no detectable FDPs. This finding is consistent with that of Van Den Ingh et al. (1976) who found FDPs in the one animal which developed DIC and died from acute trypanosomiasis. Our findings and those of Van Den Ingh et al. (1976), therefore, suggest that severe fibrinolysis occurs in acute *T. vivax* infections. Similar findings have been reported by Shitakha et al. (1983) in cattle infected with *Theileria parva* (East Coast fever) and by Maxie et al. (1982) in their comparative study of the diseases in cattle caused by *T. parva* and *T. lawrencei*.

It was not clear as to what was responsible for the activation of the clotting system in *T. vivax*-infected animals. However, *T. vivax* infections are associated with a dissemination of trypanosomes in extra and intravascular sites in the body where they cause tissue and organ damage (Losos & Ikede, 1972). Destruction of tissues could lead to the release of thromboplastin-like principles which may have been responsible for the activation of the clotting system in the infected animals. Furthermore, a release of other tissue enzymes like the Hageman factor-dependent plasminogen activator, plasma Kallikrein, could lead to the activation of plasminogen into plasmin, a proteolytic enzyme that lyases lysine and arginine bonds. Fibrinogen and fibrin, being rich in these bonds, thus become
targets for degradation by plasmin.

One of the significant findings in this work was severe thrombocytopenia in infected animals. Thrombocytopenia has been implicated as one of the major factors that promote the development of haemorrhages in *T. vivax* infections in cattle (Wellde et al., 1983). The cause of thrombocytopenia is not known. However, it could have been from the recruitment and utilization of platelets in the process of disseminated intravascular coagulation. Alternatively, it has been suggested (Davis, C.F., personal communication) that trypanosomes produce some unique substance that initiate intravascular clotting by activating another coagulation factor. The role of thrombocytopenia in enhancing disseminated intravascular coagulation in *T. vivax* infections requires further investigation.

It is suggested that DIC together with accompanying thrombocytopenia and degradation of fibrinogen and fibrin may be the cause of coagulopathy seen in haemorrhagic *T. vivax* infection in cattle.

Acknowledgement

We would like to thank Dr. B. Wellde for supplying the trypanosomes, Messrs R. Mulwa, C. Hinson and N. Mungai for technical assistance and M.R. Kibalama for typing this manuscript.

This work was conducted as part of a thesis by R.O. Olubayo for an M.Sc. at the University of Nairobi, Kenya.

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References


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The Anthelmintic Efficacy of Nematol Against Experimental *Haemonchus contortus* Infection in Goats

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Summary

The anthelmintic activity of nematol (Haloron, B. Vet. C., 3 chloro-6-hydroxy-4-methyl coumaria bis (2-chloroethyl) phosphate) was studied in experimental *Haemonchus contortus* infection in Nubian goats. The animals were infected with single doses of 400 or 500 infective *Haemonchus* larvae. Goats were treated with single doses of 3.5, 7 and 15 ml of nematol and the clinical and pathophysiological changes associated with successful therapy of *H. contortus* were described. Nematol was well tolerated and no toxic effects were detected in treated goats.

Introduction

Many investigations have been carried out on the infectivity of *Haemonchus contortus* in ruminants but experimental chemotherapeutical studies of new anthelmintic drugs in tropical countries have received less attention. There appears to be no previous record of the experimental infection of Nubian goats with *H. contortus* nor assessment of the anthelmintic activity of the drug, nematol (Haloron, B. Vet. G., 3 chloro-7-hydroxy-4-methyl coumaria bis (2-chloroethyl) phosphate; Thomas Pettifer and Company Ltd, England) in this species of animal.

This paper describes the efficacy of nematol against an experimentally induced *H. contortus* infection in Nubian goats.

Materials and Methods

Animals

Nine 6-14 month-old Nubian goats of both sexes were used. They were kept in pens at the Faculty of Veterinary Science, University of Khartoum and fed on lucerne and water was supplied *ad libitum*. The goats were divided into five groups. Goats 1 and 2 (group I) were each orally infected with 500 third stage *Haemonchus* larvae. Goats 3 and 4 (group II) were each infected with 500 *Haemonchus* larvae and were then dosed orally with 3.5 ml of nematol on day 42. Goats 5 and 6 (group III) were each infected with 400 *Haemonchus* larvae and received 7 ml of nematol on day 22. Goat 7 (group IV) was infected with 500 *Haemonchus* larvae and received 15 ml of nematol on day 42. Goats 8 and 9 (group V) were kept as untreated uninfected controls.

Blood Samples

The goats were bled from the jugular vein on several occasions before and at intervals after infection with *H. contortus* and treated with nematol for chemical investigations on serum and the examination of blood cells.

Parasitological Methods

Faeces were collected from goats naturally infected with *H. contortus* in clean plastic petri-dishes. The faecal samples were sealed and immediately taken to the laboratory for examination. The Salt flotation method described by Boddie (1969) was used for detection of *Haemonchus* eggs in faeces. Counting of the eggs in samples of faeces of the infected animals were made according to the method described by Boddie (1969). The activity of the eggs was tested and identification of the infective larvae was made according to the method described by Soulsby (1968). *Haemonchus* larvae were counted as described by Downey and Connolly (1963) and were given by the oral route to the experimental animals. At necropsy, abomasal folds and contents were washed with normal saline and the washings passed through a wire sieve. The worms were picked, separated into males and females, counted and recorded for each animal.

Haematological Methods

Blood samples were collected by jugular vein puncture into clean bottles containing
EDTA. Packed cell volume (PCV) was estimated by a micro-haematocrit centrifuge and haemoglobin by cyanmethaemoglobin technique with a haemoglobin meter (Evans Electroelenium Ltd, England). White and red blood cells (Wbc and Rbc) were counted with an improved Neubauer haemocytometer (Hawksley and Sons Ltd, England). Mean corpuscular volume (MCV) and mean corpuscular haemoglobin concentration (MCHC) were calculated from PCV, Rbc and Hb values.

Chemical Methods
Activities of serum aspartate aminotransferase (GOT) and alanine aminotransferase (GPT) were measured by the method of Reitman and Frankel (1957). Total serum protein concentrations were measured by the biuret method. Bilirubin concentrations were determined by the method of Dangerfield and Finlayson (1953). Calcium concentrations were determined by the titration method of Frankel and Reitman (1963) and ammonia concentrations by Varley's method (1969). The concentrations of serum sodium and potassium were measured with a flame photometer (Evans Electroelenium Ltd, England) and creatinine concentrations by the method of White and Frankel (1965). Magnesium concentrations were determined by the method of Frankel and Reitman (1963) and urea concentrations by White and Frankel's method (1965).

Results

Clinical Findings
Goats 1 and 2 (group I) which had been infected with 500 Haemonchus larvae showed depression, weakness of the limbs, inappetence and soft faeces on day 14 and were killed in a weak condition on day 30. Goats 3 and 4 (group II) became active and their appetite returned to normal 7 days after nematol treatment on day 42. They were killed on day 63 (21 days after dosing with nematol). In goats 5 and 6 (group III) and 7 (group IV), the visible mucous membranes, faeces and appetite returned to normal by 15 days after treatment with nematol. The untreated uninfected control goats 8 and 9 (group V) showed no clinical changes and were killed on day 36.

Parasitological Findings
Pre-and post-treatment counts of the numbers of Haemonchus eggs per gram of faeces in treated (groups II, III and IV) and infected untreated (group I) goats are given in Table 1. There was a complete absence of Haemonechus eggs in the faeces of goats in groups II, III and IV, 7 days after nematol treatment. This result was confirmed at necropsy when no adult worms were found in the abomasae of the nematol-treated goats (Table 2).

Table 1: Details of Infected and Treated Goats

<table>
<thead>
<tr>
<th>Group</th>
<th>Goat No.</th>
<th>Age (months)</th>
<th>Sex</th>
<th>No. of larvae given</th>
<th>Oral dose of nematol</th>
<th>Day on which dosed with nematol</th>
<th>Day killed</th>
<th>No. of adult larvae recovered</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Female</td>
</tr>
<tr>
<td>I</td>
<td>1</td>
<td>8.5</td>
<td>M</td>
<td>500</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>9</td>
<td>M</td>
<td>500</td>
<td>—</td>
<td>—</td>
<td>30</td>
<td>210</td>
</tr>
<tr>
<td>II</td>
<td>3</td>
<td>10</td>
<td>M</td>
<td>500</td>
<td>3.5</td>
<td>42</td>
<td>63 (21)</td>
<td>Nil</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>10</td>
<td>M</td>
<td>500</td>
<td>3.5</td>
<td>42</td>
<td>63 (21)</td>
<td>Nil</td>
</tr>
<tr>
<td>III</td>
<td>5</td>
<td>6</td>
<td>M</td>
<td>400</td>
<td>7</td>
<td>22</td>
<td>44 (22)</td>
<td>Nil</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>6</td>
<td>M</td>
<td>400</td>
<td>7</td>
<td>22</td>
<td>44 (22)</td>
<td>Nil</td>
</tr>
<tr>
<td>IV</td>
<td>7</td>
<td>12</td>
<td>F</td>
<td>500</td>
<td>15</td>
<td>42</td>
<td>62 (20)</td>
<td>Nil</td>
</tr>
<tr>
<td>V</td>
<td>8</td>
<td>6</td>
<td>F</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>36</td>
<td>Nil</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>14</td>
<td>M</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>36</td>
<td>Nil</td>
</tr>
</tbody>
</table>

( ), days after dosing with nematol.
Table 2: Faecal Egg Counts of Infected and Treated Goats

<table>
<thead>
<tr>
<th>Group</th>
<th>Goat No.</th>
<th>Dose of nematol (ml)</th>
<th>1st</th>
<th>2nd</th>
<th>3rd</th>
<th>4th</th>
<th>5th</th>
<th>6th</th>
<th>7th</th>
<th>8th</th>
<th>9th week after infection</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>1</td>
<td>—</td>
<td>Nil</td>
<td>Nil</td>
<td>4000</td>
<td>6000</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>—</td>
<td>Nil</td>
<td>Nil</td>
<td>1600</td>
<td>2000</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>II</td>
<td>3</td>
<td>3.5</td>
<td>Nil</td>
<td>Nil</td>
<td>Nil</td>
<td>1200</td>
<td>1000</td>
<td>1000</td>
<td>Nil</td>
<td>Nil</td>
<td>Nil</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>3.5</td>
<td>Nil</td>
<td>Nil</td>
<td>Nil</td>
<td>1400</td>
<td>1800</td>
<td>1300</td>
<td>Nil</td>
<td>Nil</td>
<td>Nil</td>
</tr>
<tr>
<td>III</td>
<td>5</td>
<td>7.0</td>
<td>Nil</td>
<td>Nil</td>
<td>Nil</td>
<td>600</td>
<td>Nil</td>
<td>Nil</td>
<td>Nil</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>7.0</td>
<td>Nil</td>
<td>Nil</td>
<td>Nil</td>
<td>300</td>
<td>Nil</td>
<td>Nil</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>IV</td>
<td>7</td>
<td>15</td>
<td>Nil</td>
<td>Nil</td>
<td>Nil</td>
<td>750</td>
<td>800</td>
<td>700</td>
<td>Nil</td>
<td>Nil</td>
<td>Nil</td>
</tr>
</tbody>
</table>

Nematol was given to goats 3, 4 (group II) and 7 (group IV) on day 42 and to goats 5 and 6 (group III) on day 22. All goats in groups I-IV were given Haemonchus infective larvae.

Table 3: Assessment of the Findings at Necropsy of Infected and Treated Goats

<table>
<thead>
<tr>
<th>Site</th>
<th>Finding</th>
<th>Group</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>I</td>
</tr>
<tr>
<td>Abomasum</td>
<td>Catarrhal abomasitis and erosions</td>
<td>++</td>
</tr>
<tr>
<td></td>
<td>Petechial haemorrhage in mucosa</td>
<td>+</td>
</tr>
<tr>
<td></td>
<td>Focal catarrhal enteritis</td>
<td>++</td>
</tr>
<tr>
<td></td>
<td>Fatty change</td>
<td>+</td>
</tr>
<tr>
<td></td>
<td>Serous atrophy of the epicardial fat</td>
<td>+</td>
</tr>
<tr>
<td></td>
<td>Hydroperitonene</td>
<td>+</td>
</tr>
<tr>
<td>Small intestine</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Liver</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kidney</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heart</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Peritoneal cavity</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

+, ++, ++++, increasing severity of lesions.
( ), absence of lesions.

Post-mortem Findings

The post-mortem findings in the infected and treated goats are summarized in Table 3. In the untreated infected goats 1 and 2 (group I), there were small necrotic areas and petechial haemorrhages in the abomasal mucosa, focal catarrhal enteritis, hydroperitonene, serious atrophy of the epicardial fat, hepatic fatty change and enlargement of the mesenteric and hepatic lymph nodes. The lesions in goats 3 and 4 (group II) were similar to those found in group 1 animals but erosions and haemorrhages in the abomasal mucosa, catarrhal enteritis and hepatic fatty change were less marked. There were no significant changes in goats in groups III, IV and V.

Histological Findings

In goats in groups I and II, the abomasal mucosa showed foci of haemorrhages and congestion and packing of the lamina propria with mononuclear cells and desquamation of epithelial cells in the mucous exudate. The mucous membrane of the small intestine showed inflammatory changes. The exudate consisted of mucus, desquamated epithelial cells and leucocytes. The hepatic parenchymal cells showed focal cytoplasmatic fatty vacuolation and congestion of the sinusoids. The cells of some renal convoluted tubules were vacuolated. In goats of groups III and IV, the abomasum, small intestine, liver and kidney had almost returned to normal except for a few scattered erosions in the abomasal mucosa.
Changes in Serum Constituents

There was no change in the concentrations of bilirubin, calcium, urea and magnesium and in the activity of GPT in the serum of any goat. The activity of GOT and concentrations of total protein, ammonia, sodium, potassium and creatinine in the serum of goat 1 are representative of the changes in goats 1 and 2. Figure 1 shows the activity of GOT; the concentrations of potassium, sodium, ammonia and creatinine began to rise on the day 13 after infection with

Figure 1: Serum changes in goat 1 in group I, infected with 500 larvae of *H. contortus* on day 0.

Figure 2: Serum changes in goat 4 in group II during infection with *Haemonchus* larvae on day 0 and treatment with a single dose of 3.5 ml of nematol on the day indicated by the arrow.

*H. contortus* and did not return to normal when the animal was killed on day 30. The concentration of total protein fell terminally. Changes in the concentration of ammonia, total protein, creatinine, sodium and potassium and in the activity of GOT in the serum of goats 3 and 4 were similar. In goat 4 (Fig. 2), the concentrations of ammonia, potassium, creatinine and the activity of GOT gradually fell following the oral administration of 3.5 ml of nematol on day 42. The rise in serum protein concentration occurred between days 47 and 63. The
concentration of sodium in serum remained above normal after dosing with nematol. In goat 7 (Fig. 3) which received a single oral dose of 15 ml of nematol on day 42, there were slight terminal increases in the concentrations of serum potassium, creatinine, total protein and ammonia and in the activity of GOT.

**Haematological Findings**

The haematological changes in goat 7 (group IV) are typical of nematol-treated animals. Hb, PCV and Rbc rose above post infection levels following treatment with nematol (Fig. 4).

**Discussion**

The data presented from this trial show that nematol in single oral doses of 3.5, 7 and 15 ml is effective in eliminating *H. contortus* infection in goats. If cure is defined as an abomasum free from parasites 3 weeks after dosing with nematol, 100% cure was achieved against *H. contortus*. Nematol was well tolerated and no toxic effects were detected in treated goats. Since efficacy of nematol remains high against *H. contortus* it should prove to be economically useful as retreatment seems unnecessary. It is generally accepted that some nematocidal drugs such as phenothiazine possess an activity against *H. contortus* which approaches 100% effectiveness but untoward reactions have
been described in susceptible domesticated animals (Clarke and Clarke, 1967; Jones, 1968).

The condition of the nematol-treated goats based on a visual assessment, followed by the rises in serum protein concentration, Hb, PCV and Rbc counts, the falls in the concentrations of ammonia, creatinine and potassium and in the activity of GOT in serum and gradual return to normal histological appearance of the abomasum, small intestine, liver and kidney indicate a high efficacy of the drug against *H. contortus*. Therapy with nematol, therefore, could be a useful adjunct to hygiene and management control of *Haemonchus* infection in goats.

Acknowledgements

This work was undertaken by Um El Alim A. Idris as part of an M.V.Sc. training programme in the University of Khartoum and was financed by the Graduate College of the same University. We thank Messrs H.E. El Tayeb and E.E. El Mahi for technical assistance.

References


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Leucocytic Formula of Guinean Goats

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Summary

Forty-nine samples of blood were collected from some Guinean goats in the area of Bamenda, North-West Province of Cameroon. The total blood count of the white corpuscles as well as the respective percentages of each type of white cell have been determined. The number of worm ova in the gastro-intestinal tract has also been determined for a part of the animals.

Introduction

The blood groups of Guinean goats are relatively unknown. This has led us, the authors, to collect some blood samples from some of these animals in order to determine first of all, their leucocytic formulae.

The frequency of blood parasites and gastro-intestinal parasite infestations are known to be very high in the Bamenda area, so we deemed it necessary to determine these formulae in some of the animals, all showing signs of good health.

Materials and Methods

The animals were randomly selected after a general clinical examination. The population was represented by 30 female goats, 11 male goats and eight young goats.

None presented any diarrhoeal or other symptoms making it possible to suspect some sort of pathology. Samples of faeces were collected from a part of the animals which seemed to us to be representative of the population and the OPG (number of ova per gramme of faeces) was measured by the Mac Master method. This enabled us to conclude that the gastro-intestinal worm infestation was moderate and did not constitute a pathology.

The blood was collected in citrated tubes, at the level of the jugular vein. The total count of leucocytes was determined by means of a Thoma cell. The leucocytic formula was determined on a blood smear fixed in alcohol and coloured in May Grunwald-Giemsia. Before that, the absence of blood parasites was confirmed by an examination of a smear coloured in Giemsia.

Results

The mean as well as the maximum and the minimum values obtained are reproduced in Table 1.

<table>
<thead>
<tr>
<th>Animals</th>
<th>White corpuscles (unit/mm³)</th>
<th>Basophils</th>
<th>Polynuclear eosinophils Rs. (%)</th>
<th>Neutrophils</th>
<th>Lymphocytes (%)</th>
<th>Monocytes (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total population (5,700-25,000)</td>
<td>11,255 (0-3.9)</td>
<td>0.4</td>
<td>8 (0.8 - 18.6)</td>
<td>40</td>
<td>48</td>
<td>2.2 (0-6.2)</td>
</tr>
<tr>
<td>Female goats (7,200-17,900)</td>
<td>11,440 (0-3.9)</td>
<td>0.5</td>
<td>8 (0.9 - 18.6)</td>
<td>42</td>
<td>46</td>
<td>2.3 (0-6.2)</td>
</tr>
<tr>
<td>Male goats (7,200-25,000)</td>
<td>12,709 (0-1.5)</td>
<td>0.4</td>
<td>7 (2.7-15.1)</td>
<td>38</td>
<td>50</td>
<td>2.4 (0.7 - 5.7)</td>
</tr>
<tr>
<td>Young goats (5,700 - 12,700)</td>
<td>8,562 (0-1.6)</td>
<td>0.4</td>
<td>6 (0.8 - 12)</td>
<td>37</td>
<td>55</td>
<td>1.7 (0.8 - 2.4)</td>
</tr>
</tbody>
</table>

Work carried out in the Cameroon.
Table 2

<table>
<thead>
<tr>
<th>References</th>
<th>White corpuscles (unit/mm³)</th>
<th>Basophils</th>
<th>Polynuclear eosinophils (%)</th>
<th>Neutrophils (%)</th>
<th>Lymphocytes (%)</th>
<th>Monocytes (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brion</td>
<td>7,000-10,000</td>
<td>0.8</td>
<td>3</td>
<td>33</td>
<td>60</td>
<td>2</td>
</tr>
<tr>
<td>Schalm</td>
<td>6,000-16,000</td>
<td>0.2</td>
<td>3.8</td>
<td>30-50</td>
<td>50-70</td>
<td>1-4</td>
</tr>
</tbody>
</table>

Table 3

<table>
<thead>
<tr>
<th>White corpuscles per mm³</th>
<th>Brion Higher</th>
<th>Brion Lower</th>
<th>Schalm Higher</th>
<th>Schalm Lower</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>30</td>
<td>4</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>Basophils (%)</td>
<td>12</td>
<td>34</td>
<td>1</td>
<td>—</td>
</tr>
<tr>
<td>Eosinophils (%)</td>
<td>42</td>
<td>6</td>
<td>23</td>
<td>6</td>
</tr>
<tr>
<td>Neutrophils (%)</td>
<td>37</td>
<td>12</td>
<td>12</td>
<td>10</td>
</tr>
<tr>
<td>Lymphocytes (%)</td>
<td>11</td>
<td>38</td>
<td>3</td>
<td>26</td>
</tr>
<tr>
<td>Monocytes (%)</td>
<td>25</td>
<td>22</td>
<td>5</td>
<td>13</td>
</tr>
</tbody>
</table>

Discussion

Table 3 gives the number of cases out of 49 in which values higher or lower than the reference groups given in Table 2, were found.

A comparison of the results observed in the reference groups in Table 2, gives an eosinophilic percentage often higher than these references (86% of cases in comparison with Schalm) and an often lower rate of lymphocytes (78% of cases in comparison with Brion, 53% of cases in comparison with Schalm).

Acknowledgements

This work was carried out under the project entitled: Assistance to Traditional Breeders of Small Ruminants, which received the Co-financing of the Central Administration of Belgium for Development Cooperation.

We wish to thank Mr. Luc Obounou Zibi, a technician at the Mankon-Bamenda Station of the Institute of Animal Husbandry Research in the Cameroon, whose assistance and expertise contributed immensely to the accomplishment of this task.

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Schalm, O.W. Veterinary Hematology. Lea and Febiger.

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Escherichia coli O.K.H. Serotypes in Strains Isolated in Nigeria from Kids, Lambs, Calves and Piglets with Diarrhoea

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Summary

Escherichia coli associated with diarrhoea in calves, lambs, kids and piglets were serotyped. Few strains belonged to serotypes commonly associated with neonatal diarrhoea in domestic animals living in more temperate climates.

Introduction

Classification of Escherichia coli is based on certain fermentative properties such as indol production, lactose utilization, acid and gas from glucose, utilization of sorbitol, xylose, trehalose, arabinose, maltose, oxidase and methyl red, and upon the determination of O:K and H antigens (Sojka, 1971). During the past 20 years a number of articles have been published concerning E. coli serotypes involved in diarrhoea in livestock. From these articles it was observed that in Europe, Canada and the U.S.A. certain serotypes of E. coli, often enterotoxigenic, have been associated with diarrhoea in piglets, calves and lambs (Terlecki and Shaw, 1959; Gay, 1965; Sojka, 1965; Moon et al., 1966; Glantz, 1971; Furowitz and Ørskov, 1972; Glantz et al., 1973; Ørskov and Ørskov, 1979). In addition to the common enterotoxigenic E. coli, Guinee et al. (1977) found some enterotoxigenic serotype strains causing death in piglets in the Netherlands.

This paper reports serotyping of E. coli isolated from cases of diarrhoea in livestock raised on many farms located in different parts of Oyo State of Nigeria.

Materials and Methods

During the rainy seasons of 1976 to 1978 from June to August of each year, faecal samples were collected from 35, 24, 12 and 5 diarrhoeic kids, piglets, calves and lambs respectively. These animals were raised on different farms located in Oyo State of Nigeria. The faecal samples were plated on 5% sheep blood agar, MacConkey agar, and incubated at 37°C overnight. The diagnosis of E. coli was conducted following standard methods. The E. coli isolates were then lyophilised and stored at -20°C until needed for serological studies. The lyophilised cultures were plated in broth agar plates. Biotyping of each culture was made by inoculating a single isolated colony into the following biochemical sugars: dulcitol, adonitol, inicol, salicin, xylose, raffinose, rhamnose, sucrose, glucose, indole, lactose, KCN, methyl red, ammonium citrate, ammonium glucose, voges proskauer, christensen urea agar, malonate, sorbitol, gelatin.

Serological Grouping

The isolates were analysed in detail for O and H antigens according to the method of Ørskov and Ørskov (1975), using antisera against O and H antigens as routinely used at the Statens Serum Institute, International Centre for Escherichia coli and Klebsiella, Copenhagen, Denmark.

K Antigen Determination

The presence of K antigen was determined by agarose electrophoresis combined with second dimensional cetavion precipitation (Ørskov, 1976). K antigen determination was carried out by counter current immuno-electrophoresis (CIE) according to the method of Semjen et al. (1977).

Strains were examined for K1 antigen according to the method of Sarff et al. (1975), using equine meningococcal group B antiserum prepared by intravenous injection of formaldehyde-fixed meningococcus group B (strain B-11). This antiserum containing approximately 0.5 mg of anti K1 capsular polysaccharide antibody per ml, was mixed (1:10 V/V) with trypctase soy broth (TSB) plus agarose at a final concentration of 1.5%. The cultures were streaked onto antiserum agar and incubated overnight at 37°C. After
initial examination for haloes of precipitation the plates were incubated for an additional 24 hours at 4°C and reinspected, using a high-intensity spotlight against a dark background. This second inspection occasionally revealed a previously undetected halo producing colony.

Strains belonging to O groups which are commonly associated with K98 and K99 antigens were examined for these antigens by slide agglutination.

Haemolysis

The E. coli isolates were examined for haemolysis on 5% sheep blood agar.

Results and Discussion

The fundamental data from this investigation are shown in Tables 1 - 3.

Table 1: O:H:K: Serotypes of E. coli Isolated from Kids

<table>
<thead>
<tr>
<th>Serotypes</th>
<th>No. of strains</th>
</tr>
</thead>
<tbody>
<tr>
<td>02:K:H40</td>
<td>1</td>
</tr>
<tr>
<td>03:K:H31</td>
<td>1</td>
</tr>
<tr>
<td>04:K:H1</td>
<td>1</td>
</tr>
<tr>
<td>05:K:H1</td>
<td>1</td>
</tr>
<tr>
<td>08:K:H1</td>
<td>1</td>
</tr>
<tr>
<td>08:K:H7</td>
<td>2</td>
</tr>
<tr>
<td>08:K:H21</td>
<td>1</td>
</tr>
<tr>
<td>018:ab:K:H1</td>
<td>2</td>
</tr>
<tr>
<td>026:K:H11</td>
<td>2</td>
</tr>
<tr>
<td>058:K:H25</td>
<td>1</td>
</tr>
<tr>
<td>068:K:H1</td>
<td>1</td>
</tr>
<tr>
<td>068:K:H11</td>
<td>2</td>
</tr>
<tr>
<td>071:K:H25</td>
<td>2</td>
</tr>
<tr>
<td>077:K:H18</td>
<td>1</td>
</tr>
<tr>
<td>078:K:H7</td>
<td>1</td>
</tr>
<tr>
<td>082:K:H1</td>
<td>2</td>
</tr>
<tr>
<td>083:K24:K21</td>
<td>2</td>
</tr>
<tr>
<td>083:K:H21</td>
<td>2</td>
</tr>
<tr>
<td>0103:K:H spontaneous agglutination</td>
<td>1</td>
</tr>
<tr>
<td>0103:K:H1</td>
<td>1</td>
</tr>
<tr>
<td>0108:K:H1</td>
<td>1</td>
</tr>
<tr>
<td>0110:K:H2</td>
<td>1</td>
</tr>
<tr>
<td>0126:K:H8</td>
<td>1</td>
</tr>
<tr>
<td>0128:K:H2</td>
<td>1</td>
</tr>
<tr>
<td>0140:K:H32</td>
<td>1</td>
</tr>
<tr>
<td>0150:K:H1</td>
<td>1</td>
</tr>
<tr>
<td>0 spontaneous agglutination: H2</td>
<td>1</td>
</tr>
<tr>
<td>Total examined</td>
<td>35</td>
</tr>
</tbody>
</table>

K" = negative in CIE when examined in the 103 K antisera.
H" = negative in 56 H antisera.
H? = not determined by H1 to H6.

Table 2: E. coli Serotypes Isolated from Piglets with Diarrhoea

<table>
<thead>
<tr>
<th>Serotypes</th>
<th>No. of isolates</th>
</tr>
</thead>
<tbody>
<tr>
<td>06:K1:H26</td>
<td>1</td>
</tr>
<tr>
<td>07:K1:H7</td>
<td>1</td>
</tr>
<tr>
<td>07/071:K1:H4</td>
<td>1</td>
</tr>
<tr>
<td>07:K:H5</td>
<td>1</td>
</tr>
<tr>
<td>08:K:H17</td>
<td>2</td>
</tr>
<tr>
<td>09:K41:H7/K99+</td>
<td>1</td>
</tr>
<tr>
<td>180ac:K:H8</td>
<td>1</td>
</tr>
<tr>
<td>039:K:H21</td>
<td>1</td>
</tr>
<tr>
<td>041:K:H9</td>
<td>1</td>
</tr>
<tr>
<td>078:K:H7</td>
<td>1</td>
</tr>
<tr>
<td>079:K:H14</td>
<td>1</td>
</tr>
<tr>
<td>089:K:H38</td>
<td>2</td>
</tr>
<tr>
<td>098:K:H1</td>
<td>1</td>
</tr>
<tr>
<td>0103:K:H1</td>
<td>1</td>
</tr>
<tr>
<td>0159:K:H8</td>
<td>1</td>
</tr>
<tr>
<td>Negative in 01 — 0164:K:H25</td>
<td>1</td>
</tr>
<tr>
<td>&quot; &quot; &quot; &quot;  &quot; K&quot;:H25</td>
<td>1</td>
</tr>
<tr>
<td>&quot; &quot; &quot; &quot;  &quot; K&quot;:H26</td>
<td>3</td>
</tr>
<tr>
<td>&quot; &quot; &quot; &quot;  &quot; K&quot;:H4</td>
<td>1</td>
</tr>
<tr>
<td>0 spontaneous agglutination: K28H&quot;</td>
<td>1</td>
</tr>
<tr>
<td>Total examined</td>
<td>24</td>
</tr>
</tbody>
</table>

K" = negative in CIE when examined in the 103 K antisera.
H" = negative in 56 H antisera.
H? = not determined by H1 to H6.

Table 3: E. coli Serotypes Isolated from Calves and Lambs

<table>
<thead>
<tr>
<th>Serotypes</th>
<th>No. of strains</th>
<th>Species from which collected</th>
</tr>
</thead>
<tbody>
<tr>
<td>08/060:K41:H7</td>
<td>1</td>
<td>Calf</td>
</tr>
<tr>
<td>015:K&quot;:H51</td>
<td>1</td>
<td>&quot;</td>
</tr>
<tr>
<td>018ab:18ac:K&quot;:H17</td>
<td>1</td>
<td>&quot;</td>
</tr>
<tr>
<td>020:K&quot;:H30</td>
<td>1</td>
<td>&quot;</td>
</tr>
<tr>
<td>023:K&quot;:H4</td>
<td>1</td>
<td>&quot;</td>
</tr>
<tr>
<td>023:K&quot;:H31</td>
<td>1</td>
<td>&quot;</td>
</tr>
<tr>
<td>026:K&quot;:H11</td>
<td>1</td>
<td>&quot;</td>
</tr>
<tr>
<td>083:K1:H1</td>
<td>1</td>
<td>&quot;</td>
</tr>
<tr>
<td>0152:K&quot;:H45</td>
<td>1</td>
<td>&quot;</td>
</tr>
<tr>
<td>037:K&quot;:H10</td>
<td>1</td>
<td>Lamb</td>
</tr>
<tr>
<td>084:K&quot;:H7</td>
<td>1</td>
<td>&quot;</td>
</tr>
<tr>
<td>084:K&quot;:H34</td>
<td>1</td>
<td>&quot;</td>
</tr>
<tr>
<td>0101:K&quot;:K99 + H9</td>
<td>1</td>
<td>&quot;</td>
</tr>
<tr>
<td>0150:K&quot;:H8</td>
<td>1</td>
<td>&quot;</td>
</tr>
<tr>
<td>07:K&quot;:H1</td>
<td>1</td>
<td>Calf</td>
</tr>
<tr>
<td>015:K&quot;:H7</td>
<td>1</td>
<td>&quot;</td>
</tr>
<tr>
<td>07:K&quot;:H4</td>
<td>1</td>
<td>&quot;</td>
</tr>
</tbody>
</table>

K" = negative in CIE when examined in the 103 K antisera.
H" = not determined by H1 to H6.
H? = not determined by H1 to H6.

K" = negative in CIE when examined in the 103 K antisera.
K₁ antigen was detected in three pig strains and one calf strain. Seven strains had K₁ antigens. Two strains had K₉, one of these was isolated from a piglet. The serotype of this strain was 09: K₄₁: H₁ (Table 2) while the other was isolated from a lamb, the serotype being 0101:K₉:H₁₂ (Table 3). No K₈₈ antigen was detected. Seven strains were haemolytic on 5% sheep blood agar. Ten of the strains examined were spontaneously agglutinable and could not be O grouped. O groups 08 (7 strains), 068 (3 strains), 026 (3 strains), 018ab (2 strains), 0103 (3 strains), 084 (2 strains) and 083 (4 strains) were the most commonly found. Three of the strains produced H:S and eight others decomposed urea.

It is well known that certain serotypes of E. coli are associated with diarrhoeic disease of newborn and weaning pigs (Sjojka, 1971; Ørskov and Ørskov, 1979). Few of such serotypes were found in this investigation. There are few reports of E. coli serotypes causing diarrhoea in kids and goats. The serotypes of E. coli isolated from cases of diarrhoea in kids are shown in Table 1. Two of the strains belong to serotype 026:K₄:H₁₁: Ørskov (1951) originally isolated this serotype from infants with diarrhoea. That this serotype is isolated from these kids with diarrhoea is evidence that the serotype is a potential pathogen of diarrhoea in humans and livestock. It might be possible with good assay methods to detect enterotoxin from the strains.

In this investigation it was observed that one strain of E. coli isolated from a piglet had K₉ antigen. This finding confirms the reports of Moon et al. (1977) that K₉ antigen is not limited to E. coli isolates from calves and lambs. The O:K:H serotypes found in other parts of the world associated with neonatal diarrhoea (Sjojka, 1971; Ørskov and Ørskov, 1979) in pigs were not detected. Among the calf strains found in the present study were some O groups and O:H groups earlier reported in association with neonatal calf diseases (Rees, 1958; Sjojka, 1965; Gay, 1965). Previous studies on calf and lamb E. coli strains showed that three E. coli strains of serotype 026:K₄:H₁₁, 015:K₉:H₁₁, 015:K₉:H₁₁ and serogroup 08 from calves with diarrhoea and serotype 0101:K₉:H₁ isolated from a lamb, dilated ligated intestinal loops of rabbit with accumulation of fluid, thus indicating that the strains were enterotoxigenic (Adetosoye, 1980). This observation confirms the study of Smith and Halls (1967) in which E. coli serogroups 08, 09, 0101 and OB44 isolated from severe cases of diarrhoea dilated the ligated intestine of calves and lambs. It was observed that the three H:S producing E. coli did not transfer this character to E. coli K₉₁ (Adetosoye and Ojo, in press) while seven of the eight E. coli which decomposed urea transferred this character to E. coli K₁₂ (Adetosoye and Ojo, 1983).

Nigeria derives much foreign exchange from the sale of hides and skins of sheep, goat and cattle. Goat meat provides 40% of meat to the Nigerian population. It is suggested that attention should be paid to the health of livestock in Nigeria.

Acknowledgement

Many thanks are expressed to the Danish International Development Agency for the scholarship award which enabled me to carry out this investigation at the Serum Institut, Copenhagen. Thanks are expressed to Drs. Ida and Frits Ørskov for allowing me to use the facilities in their laboratory and to all the staff of the Coli department, Statens Serum Institute, Copenhagen, who made my stay in the laboratory very meaningful and to Mr. Matthew Oladele who typed this manuscript.

References

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Reduction of Virulence of *Pasteurella haemolytica* in Mice After Eight Years of Storage in the Laboratory

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Department of Veterinary Microbiology and Parasitology

and  
O. KASALI  
Department of Veterinary Pathology,  
University of Ibadan, Ibadan, Nigeria

**Summary**

The pathogenicity of *Pasteurella haemolytica* in mice after 8 years of storage was determined using 7-8 week old white Swiss albino mice. The *Pasteurella haemolytica* was not pathogenic for mice although the virulence was enhanced by intraperitoneal injection of mucin with the bacterium.

**Introduction**

*Pasteurella haemolytica* is commonly found in the upper respiratory passages of healthy animals and is generally regarded as an opportunist pathogen associated with serious animal diseases such as pneumonia of cattle, sheep and goats and septicaemia in lambs (Anosa and Isoun, 1975; Ojo, 1976); debilitating diseases, strongylosis, coccidiosis and sudden changes in diet (Nesvadba, 1960; Anosa and Isoun, 1975).

Some investigators in Europe, Canada and United States found that this organism has an important role to play in “shipping fever” of cattle (Florent and Godbille, 1950; Carter, 1954; Carter and Mcsherry, 1955; Collier *et al.*, 1962).

The present study was carried out to determine whether strains of *P. haemolytica* could still be pathogenic to mice without enhancement after 8 years of “storage” in the lyophilised form and kept at 4°C.

**Materials and Methods**

**Strains**

Forty-eight *Pasteurella haemolytica* strains isolated from pneumonia in sheep and goats 8 years ago were used. The bacteriological and biochemical characteristics of these strains have been reported (Ojo, 1975). Each strain was inoculated into trypticase soy broth (TBS), kept at 37°C overnight. Then serial dilutions were made with eight Khan tubes up to a dilution of 1:1280. Using 50-dropper pipettes one drop from each dilution was delivered onto 5% sheep blood agar, seeded and incubated overnight at 37°C. The viable count was calculated as described by Miles and Mistras (1938).

**Pathogenicity Test**

**Experiment I.** Three Swiss albino mice 7-8 weeks old were randomly selected regardless of sex from a group of 419 mice. These mice were decapitated and the tracheal washings of each was cultured on 5% sheep blood agar overnight at 37°C, to make sure they were not carrying *Pasteurella haemolytica*. The remaining mice were housed in plastic cages and provided with mice cubes and water ad libitum. Four mice were used per strain, two were injected intraperitoneally and two subcutaneously with 0.5ml of broth culture containing 5 x 10⁸ viable organisms per ml of overnight broth culture as described by Ojo (1975). The mice were observed for clinical signs daily for 6 weeks before they were sacrificed.

**Experiment II.** Ninety-six mice were used
for the second experiment. Two mice were used per strain, the mice were inoculated intraperitoneally with 0.5 ml containing $5 \times 10^8$ viable organisms per ml of overnight broth culture followed by 0.5 ml of 5% mucin as described by Biberstein and Thompson (1965) to enhance the pathogenicity of the organism. Dead mice were necropsied immediately. No mouse lasted more than 48 hours.

Experiment III. A group of ten adult mice were inoculated intraperitoneally with 0.5 ml of the broth culture containing $5 \times 10^8$ viable organisms per ml, while another group of ten mice were inoculated subcutaneously with 0.5 ml of the broth culture containing $5 \times 10^8$ viable organisms per ml. The adult mice were observed for 6 weeks.

For control 0.5 ml of 5% mucin was injected intraperitoneally into six mice. All dead and sacrificed mice were necropsied. Samples from the kidney, liver, spleen, heart and perfused lungs, were taken for histopathological studies. These were fixed in 10% formal-saline, embedded in paraffin wax and sectioned at 5-6 μm. The sections were stained with haemotoxylin and eosin (H & E).

**Results**

None of the mice used in the first and third experiments died. However all the mice inoculated intraperitoneally with *Pasteurella haemolytica* together with 5% mucin in experiment II died. Sixty-eight (60.7%) died within 18-24 hours and the remaining 32 (39.3%) died 24-48 hours later. The dead mice showed accelerated respiration, huddling, chilling, hair stood on end and eyes closed. They were unwilling to move, eat or drink. They were dull and distressed. In those mice injected intraperitoneally with *Pasteurella haemolytica* without mucin there was only transient depression and dullness for a few hours and they recovered completely.

The lungs of dead mice were congested, haemorrhagic and oedematous. Histopathologically, the alveolar septa and blood vessels were congested. The hepatic sinusoids and the centrolobular veins were also congested. In one mouse a few lymphocytes infiltrated the wall of a vein in the portal triad. There was congestion of medullary spaces in the spleen. The medullary areas of the kidney showed marked congestion.

<table>
<thead>
<tr>
<th>Route</th>
<th>No. of mice Inoculated</th>
<th>Mortality 18-24h</th>
<th>Mortality 24-48h</th>
</tr>
</thead>
<tbody>
<tr>
<td>I.P.</td>
<td>96</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>S/C</td>
<td>96</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>I.P.</td>
<td>96</td>
<td>68</td>
<td>28</td>
</tr>
<tr>
<td>S/C</td>
<td>10</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>I.P.</td>
<td>10</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>S/C</td>
<td>10</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Control Experiment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I.P.</td>
<td>6</td>
<td>0*</td>
<td></td>
</tr>
<tr>
<td>S/C</td>
<td>6</td>
<td>0*</td>
<td></td>
</tr>
</tbody>
</table>

*In the control experiment — mucin only.

*Pasteurella haemolytica* was isolated from the liver, spleen, lungs, kidneys, heart blood and peritoneal fluid of all the mice that died.

In the control mice inoculated with mucin only, there were no clinical signs and no pathological lesions were observed.

**Discussion**

From the investigation primarily carried out by Ojo (1975), it was observed that 32 of the strains studied here were pathogenic for mice by the intraperitoneal route and none of them killed mice when inoculated subcutaneously. However in this investigation none of the 48 *Pasteurella haemolytica* strains was pathogenic to mice when administered intraperitoneally without mucin. The reduced virulence of the *Pasteurella haemolytica* strains used in this study was probably due to several years of storage or due to several subcultures (11 times) on artificial media. However 100% mortality was recorded when mucin was injected with the organism intraperitoneally. This is due to the action of mucin which prevents phagocytosis thereby enhancing the multiplication of the test
organisms (*P. haemolytica*) resulting in septicemia and death of the mice. There were no clinical signs and mortality recorded in the adult mice in this study. This confirms the work of Biberstein and Thompson (1965), Janetschke and Risk (1970) and Ojo (1975), showing that younger mice are more susceptible than adult mice.

The clinical signs were classical and compared favourably with the findings of several workers (Gale et al., 1961; Jensen et al., 1976; Jericho and Langford, 1977; Walker et al., 1980).

The pathological findings like congestion of the liver of the dead mice confirmed the findings recorded in cattle by Gale et al. (1961), Friend et al. (1976), Jensen et al. (1976); in sheep by Biberstein et al. (1971); and in goats by Pande (1943), Gourlay and Barber (1960), Mugera and Kramer (1967). From this work it is concluded that several years of storage and subculturing on artificial media have reduced the virulence of *P. haemolytica* to mice.

**Acknowledgement**

The advice and criticism of Dr. A.I. Adetosoye is greatly appreciated.

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**References**


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Mycoplasma sp. from Pneumonic Goats and Sheep in Eastern Nigeria

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Department of Veterinary Pathology and Microbiology University of Nigeria, Nsukka

Summary

Pneumonia among West African dwarf goats and sheep in Eastern Nigeria was investigated to ascertain its bacterial etiology with particular reference to Mycoplasma sp. The concomitant lung lesions and the cellular changes manifested were also studied. Most of the specimens were obtained at necropsy. Of the 82 goats and 29 sheep investigated, 14 goats and 4 sheep were found to be infected with Mycoplasma spp. either alone or in association with, Pasteurella multocida, Corynebacterium pyogenes, haemolytic Streptococcus spp. or Staphylococcus aureus. Isolations from goats included M. mycoides subsp. mycoides (L.C.), M. agalactiae and three other strains which could not be typed serologically. M. arginini and M. ovipneumoniae were isolated from sheep. This appears to be the first report of isolation of M. ovipneumoniae in Nigeria.

The cellular changes in the lungs infected with M. mycoides and M. arginini simulated CCPP, whereas interstitial pneumonia and emphysema were discernible in cases of M. ovipneumoniae infections. Extensive consolidation and focal necrosis were observed in the lungs colonised by M. agalactiae. These changes have been discussed in the light of the pathology of CCPP attributable to Mycoplasma strain F38 recently isolated from Kenya.

Introduction

The front ranking health problem of goats and to a lesser extent of sheep in different States of Nigeria is considered to be pneumonia either alone or complicated with other pathological manifestations (Ndua and Ihemelandu, 1973; Okoh and Kaldas, 1980; Ojo, 1976, 1976a). Our own records of necropsy carried out between 1973 and 1980 on goats and sheep on the University Farm, Nsukka corroborate this view. This study was, therefore, undertaken to investigate the etiology of pneumonia of goats and sheep in Eastern Nigeria with particular reference to Mycoplasma sp. and the concomitant pathological lesions discernible. The study was carried out between 1979 and 1980 on West African dwarf goats and sheep.

Materials and Methods

Materials were collected from the University Farm, Nsukka, Veterinary Clinics, Enugu and Nsukka as well as from the animals/specimens received from various veterinary surgeons for post-mortem diagnosis or bacteriological investigation. Pieces of lungs and pleural exudate were collected from the dead animals at necropsy and nasopharyngeal swabs were obtained from the sick ones.

The samples were processed for the isolation of Mycoplasma using 'Bacto PPLO Broth Base' (Difco) containing Bacto-beef heart infusion, Bacto peptone and sodium chloride. The broth base was supplemented with 2.5 g of yeast extract (Oxoid), 1.0 ml of 2% thallium acetate, 1.0 ml of 0.2% DPN (Sigma), 1.0 ml of 0.5% phenol red, 100 mg of ampicillin suspension and 20 ml of inactivated horse serum to every 77 ml of the basal medium, adjusted finally to pH 7.4. The serum and DPN presterilized by filtration, were added along with ampicillin after autoclaving. Isolates of Mycoplasma sp. after being cloned twice on mycoplasma agar, the ‘Bacto PPLO Broth base’ with 0.5% Difco agar added were subjected to biochemical and physiological tests as described by Aluotto et al. (1970). In addition, sensitivity to 0.5% digitonin was also tested on mycoplasma agar employing 5 mm diameter filter paper discs impregnated with one drop of the digitonin solution. The test was run on a 24-hour old broth culture adjusted to contain approximately 10⁴ o 10⁵ viable cells per ml. Detailed serological typing of the isolates was carried out at the FAO/WHO Mycoplasma Reference Centre, Aarhus, Denmark. The serological tests employed were growth inhibition (GI), growth precipitation(GP) and immunofluorescence (IMF).

*Nicotinamide adenine dinucleotide/diphosphopyridine nucleotide C₂H₄N₃O₁₅P₂.
Isolation of *Pasteurella, Haemophilus, Corynebacterium, Staphylococcus* and *Streptococcus* species was attempted on sheep blood and chocolate agar plates. The isolates were identified on their morphological, cultural, physiological and biological attributes as detailed by Cowan and Steel (1977).

Prior to the attempts at isolation, Gram stained impression smears of the specimens were examined. Filtration technique using 0.4 µm porosity membrane filters was employed for isolating *Mycoplasma* sp. from specimens which appeared grossly contaminated. Lung tissues from fresh carcasses, collected for histopathology, were fixed in 10% formal saline and processed for embedding in paraffin. Sections were cut at 5 µm and stained with haemotoxylin and eosin.

**Results**

Of the 82 goats and 29 sheep examined, eight goats and two sheep showed signs of pneumonia. Materials from the rest of the animals were obtained at necropsy or from whole eviscerated lung specimens received from field veterinarians. Six goats showed signs of pneumoenteritis complex (PPR) as reported by the attending veterinarians.

**Isolations**

Nasopharyngeal swab from one of the sick sheep yielded *M. ovipneumoniae* while the swabs taken from eight sick goats and another sheep proved negative for *Mycoplasma*. We also failed to isolate any *Mycoplasma* from 21 (16 goats and 5 sheep) grossly contaminated specimens.

Eighteen isolations of *Mycoplasma* spp. were made. The details are shown in Table 1. Three isolates of *Mycoplasma* could not be serologically typed since the cultures were rendered non-viable on two successive occasions on arrival at Aarhus. Biochemical and physiological properties of one of these strains resembled those of *M. agalactiae* and of the other two those of *M. mycoides* subsp. *mycoides*.

<table>
<thead>
<tr>
<th>S/No.</th>
<th>Isolate</th>
<th>Host</th>
<th>Source</th>
<th>Any other pathogen</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td><em>M. mycoides</em> sub sp.</td>
<td>Goat</td>
<td>Lung</td>
<td>None</td>
</tr>
<tr>
<td>2</td>
<td>mycoides (L.C.)</td>
<td></td>
<td></td>
<td>Staph. aureus</td>
</tr>
<tr>
<td>3</td>
<td>&quot;</td>
<td>&quot;</td>
<td></td>
<td>Streptococcus</td>
</tr>
<tr>
<td>4</td>
<td>&quot;</td>
<td>&quot;</td>
<td></td>
<td>Corynebacterium pyogenes</td>
</tr>
<tr>
<td>5</td>
<td><em>M. agalactiae</em></td>
<td>Goat†</td>
<td>Pasteurella multocida</td>
<td>Streptococcus</td>
</tr>
<tr>
<td>6</td>
<td>&quot;</td>
<td>&quot;</td>
<td>&quot;</td>
<td>&quot;</td>
</tr>
<tr>
<td>7</td>
<td>&quot;</td>
<td>&quot;</td>
<td>&quot;</td>
<td>&quot;</td>
</tr>
<tr>
<td>8</td>
<td>&quot;</td>
<td>&quot;</td>
<td>&quot;</td>
<td>&quot;</td>
</tr>
<tr>
<td>9</td>
<td>&quot;</td>
<td>&quot;</td>
<td>&quot;</td>
<td>&quot;</td>
</tr>
<tr>
<td>10</td>
<td>&quot;</td>
<td>&quot;</td>
<td>&quot;</td>
<td>&quot;</td>
</tr>
<tr>
<td>11</td>
<td>&quot;</td>
<td>&quot;</td>
<td>&quot;</td>
<td>&quot;</td>
</tr>
<tr>
<td>12</td>
<td><em>Mycoplasma</em> sp. ‡</td>
<td>Goat</td>
<td>&quot;</td>
<td>Streptococcus</td>
</tr>
<tr>
<td>13</td>
<td>&quot;</td>
<td>&quot;</td>
<td>&quot;</td>
<td>C. pyogenes</td>
</tr>
<tr>
<td>14</td>
<td>&quot; ‡</td>
<td>&quot;</td>
<td>&quot;</td>
<td>Streptococcus</td>
</tr>
<tr>
<td>15</td>
<td><em>M. arginini</em></td>
<td>Sheep</td>
<td>&quot;</td>
<td>C. pyogenes</td>
</tr>
<tr>
<td>16</td>
<td><em>M. ovipneumoniae</em></td>
<td></td>
<td>&quot;</td>
<td>Staph. aureus</td>
</tr>
<tr>
<td>17</td>
<td>&quot;</td>
<td>&quot;</td>
<td>&quot;</td>
<td>None</td>
</tr>
<tr>
<td>18</td>
<td>&quot;</td>
<td>&quot;</td>
<td>Nasal swab</td>
<td><em>P. multocida</em></td>
</tr>
</tbody>
</table>

*This strain cross-reacted with *M. mycoides* capri in IMF, GI, and GP tests.
† Clinically suspected for PPR.
‡ *M. agalactiae* (?) in biochemical tests.
** *M. mycoides* subsp. *mycoides* (?) in biochemical tests.
Other Bacteria

Other bacterial pathogens isolated were Pasteurella multocida (3), Streptococcus (7), Staphylococcus aureus (3) and Corynebacterium pyogenes (5). We could not carry out Lancefield serogrouping of the Streptococcus strains. Of the six cases clinically suspected for PPR, one yielded M. agalactiae and P. multocida, the other two were colonised with P. multocida alone and from the remaining three we isolated Streptococcus spp.

Representative strains of the serologically typed Mycoplasma spp. have been deposited with the FAO/WHO Mycoplasma Reference Centre, Aarhus. The accession numbers are M. mycoides L/C AMRC-C1570; M. agalactiae C-1596; M. ovipneumoniae C-1687; and M. arginini C-1717.

Gross Lesions

Gross lesions in goats and sheep were not distinctive. In general, all the cases manifested consolidation and varying degrees of hepatisation of one or more lobes of the lung unilaterally. The cranial lobes (apical and cardiac) were more commonly involved. There was an associated pleurisy with adhesions to the chest wall over the lesions and straw coloured exudation into the thoracic cavity. Focal areas of necrosis with or without pus formation and varying from 1-2 cm in diameter were observed in the lungs of some goats and sheep from which either M. mycoides subsp. mycoides (L.C.), M. agalactiae (goats) or M. arginini (sheep) was subsequently isolated. The interlobular septa were dilated with fluid in the M. mycoides subsp. mycoides (L.C.) infected lungs.

Histopathology

Congestion of the vessels was marked in all cases except in M. ovipneumoniae infections; atalectasis with compensatory emphysema was also present. Septal oedema with fibrinous deposits (Fig. 1), oedema of the alveoli with infiltration of mononuclear cells (in M. mycoides) or both mononuclear and polymorphonuclear cells (in M. agalactiae and M. arginini) were observed (Fig. 2). In all three infections the necrotic areas were clearly demarcated from surrounding tissue but there was no evidence of encapsulation (Fig. 3). Some vessels draining the affected areas were thrombosed. The bronchial epithelium was hyperplastic, necrotic and desquamated and some bronchioles contained a mixture of the debris, macrophages and neutrophils.

Figure 1: Goat lung: M. mycoides sub sp. mycoides (L.C.) infection. Septal oedema with fibrinous deposits. x 40, H & E staining.

Figure 2: Goat lung: M. agalactiae infection: alveolar oedema with cellular infiltration. x 40, H & E staining.
The *M. ovipneumoniae* infection was characterised by a marked emphysema, hyperaemia of the alveolar wall, alveolar oedema with a slight macrophage infiltration and lack of interstitial oedema. Some parabronchial lymphoid hyperplasia was evident as was bronchial epithelial desquamation (Fig. 4).

**Discussion**

The relevant literature on caprine pneumonia has been recently reviewed by Ojo (1977) and Cottew (1979). In addition McMartin et al. (1980) have discussed in detail various aspects of CCPP* particularly its etiology in the light of recent isolation of a *Mycoplasma* sp. F38 from Kenya. Although in some of the goats which we investigated, the gross picture and histopathology were very similar to what have been described for strain F38 (MacOwan and Minette, 1976a, 1977) we, however, isolated from them members of *M. mycoides* subsp. *mycoides* (L.C.). Members of the *M. mycoides* group have been isolated previously also from cases of CCPP in Nigeria (Ojo, 1973, 1976a). Because of limitations and certain constraints we could not carry out infectivity experiments with our isolates.

*M. agalactiae* has been isolated from cases of caprine vulvovaginitis (Chima et al., 1981) and also from pneumonia in Nigerian goats (Ojo, 1976a). With the type of pathological lesions encountered by us and repeated isolations of this species from such lesions, we suspect that *M. agalactiae* which was the most frequently isolated species in this study is capable of causing pneumonia in goats under natural conditions in Nigeria. It is interesting to note that one of the isolates of this species was obtained from a clinically suspected PPR case.

There is no documented report of investigation of pneumonia in Nigerian sheep particularly with reference to mycoplasmosis. Consequently we cannot compare our results. In a recent study on housed sheep, Jones et al. (1979) isolated *M. ovipneumoniae* and *M. arginini* from pneumonic lungs. *Mycoplasma ovipneumoniae* was found to be frequently associated with proliferative and exudative type of pneumonia which our observation of interstitial pneumonia with alveolar oedema and marked emphysema corroborates. We got a solitary isolate of *M. arginini* from sheep and the histopathological picture in that case interestingly resembled some of the characteristics described for CCPP (Hutcheon, 1889). It is noteworthy that *M. arginini* has been experimentally found to be apathogenic for specific pathogen free lambs (Foggie and Agnus, 1972).

**Isolation of other bacteria like**
Staphylococcus, Streptococcus, P. multocida and Corynebacterium sp. are in agreement with the results of other studies (Ojo, 1976; MacOwan and Minnette, 1977).

Almost all the cases investigated by us were those which terminated in death and occurred sporadically and not in outbreak form. In many cases the course of the infection and the pathogenesis were interfered with by unsuccessful treatment. Our isolations are also not many. These aspects of our study, therefore, prevent us from drawing definite conclusions about the real role the species of Mycoplasma isolated in this study might play in initiating pneumonia in West African dwarf goats and sheep and causing the types of pathology recorded by us.

Acknowledgements

We are thankful to Prof. Henning Erno of the Animal Mycoplasma Reference Centre, University of Aarhus, Denmark for detailed aerotyping of the isolates. We also thank Dr. E.C. Appleby of the Royal Veterinary College, London for confirming our histopathological interpretations.

References


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Relationship of Strain and Reproductive Age of Chicken to the Concentrations of Certain Biochemical Parameters in Serum and Eggs

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Department of Animal Science, Faculty of Agriculture, University of Ife, Nigeria

Summary

In the first experiment 45 layers were assigned in replicates according to strain SB411, Harco and B390 respectively which are commercial hybrids in common use for egg production in Nigeria and stage of laying (34-55, 56-96 and over 96 weeks). Blood was collected from all the strains in each of the three stages of laying. Serum cholesterol (Chol), calcium (Ca) and total protein (TP) concentrations were determined. Serum concentration of Chol and Ca in each breed varied with stage (age) at laying, but total protein was not affected by strain or age at laying.

In a second experiment involving strain 390 only, nine samples of eggs were taken at each stage of laying. A sample consisted of 30 eggs taken from each laying stage. The variables measured were shell weight (ShW), shell calcium (ShCa), albumen weight (AlWb), yolk weight (YoW), total protein in albumen (TPAlb), total protein in yolk (TPYo) and cholesterol in yolk (CholYo). Mean values were recorded for each sample for each variable. This sampling process was repeated till nine samples were obtained. The strain at laying affected ShCa and YoW.

Introduction

The chicken and its eggs are sources of protein, which is in dire need in the Third World. In 1972, Omololu and Olusanya reported that chicken and eggs were not usual components of the average Nigerian’s diet. Since then, however, there has been an escalation in the consumption of chicken and eggs. These food items are sold in all markets and restaurants in Nigeria. Eggs are even hawked in the street, bus and railway terminals and public parks. Most of the chickens are from farms owned by either Government or private farmers. The egg yolk is a high source of cholesterol (Long, 1971) and a high cholesterol diet predisposes the consumer (especially middle-aged individuals) to cardiovascular diseases like arteriosclerosis (Keys, 1975).

The hypothesis to be investigated in this trial is that stage of laying affects biochemical variables such as cholesterol in yolk, protein in albumen and yolk, and calcium in the egg shell.

Materials and Methods

In the first experiment, 15 layer chickens from each of three commercial strains, namely: SB411, Harco, and B390, making a total of 45 chickens, were obtained from the University of Ife Teaching and Research Farm. These strains are in common use for egg production in Nigeria. Five chickens from each strain were in each of the following three stages of laying (a) 34-55 weeks, (b) 56-96 weeks and (c) over 96 weeks.

The chickens which were in commercial battery cages in a poultry house were fed layers mash and given water ad libitum before and during the period of the trial.

The jugular vein in the neck of each chicken was severed by a surgical blade and blood collected into plain tubes was allowed to clot. The serum was separated after centrifugation. Serum total protein concentration (TP) was determined by the Biuret method (Henry et al., 1974), while the estimation of serum calcium level (Ca) was performed by the EDTA titrimetric method, and serum cholesterol concentration (Chol) was estimated by the Lieberman Burchardt method (Varley, 1969).

Each egg shell was dissolved in 10ml of concentrated hydrochloric acid and the volume diluted to 100ml with distilled water. 0.05ml aliquots were estimated for calcium concentration (ShCa) by a titrimetric method (Varley, 1969).

The egg albumen was separated from the egg yolk and analysed separately. 0.1ml aliquots of each were used for the estimation
Table 1: Composition of Layer's Mash

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Content (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yellow maize</td>
<td>57.5</td>
</tr>
<tr>
<td>Groundnut cake</td>
<td>8.6</td>
</tr>
<tr>
<td>Brewery dried grain</td>
<td>20</td>
</tr>
<tr>
<td>Dried grain</td>
<td>20</td>
</tr>
<tr>
<td>Dicalcium sulphate</td>
<td>1.9</td>
</tr>
<tr>
<td>Oyster shell</td>
<td>7.5</td>
</tr>
<tr>
<td>Salt</td>
<td>0.5</td>
</tr>
<tr>
<td>Amprolium</td>
<td>0.5</td>
</tr>
<tr>
<td>Fish meal</td>
<td>3.5</td>
</tr>
<tr>
<td>Agricare*</td>
<td>0.5</td>
</tr>
</tbody>
</table>

*Vitamin A, Vitamin D3, Vitamin E, Vitamin K, Riboflavin, Vitamin B12, Pantothenic acid, Nicotinic acid

Choline chloride, Folic acid, Pyridoxine, Cobalt, Iodine, Copper, Manganese, Zinc

Iron, Antioxidant, Terramycin, Methionine, Lysine, Yolk colourant, Sodium chloride, Brewers yeast

of total protein in egg albumen (TPA1b) and egg yolk (TPY0 by the Biuret method (Henry et al., 1974).

Aliquots of 0.2ml from the egg yolk mixture were pipetted in each of two centrifuge tubes, 10ml of ethanol-ether mixture (3/1, v/v) was then added to the egg yolk. The extraction of cholesterol and the estimation of its concentration in egg yolk (CholYo) was then performed (Varley, 1969).

In the second experiment involving strain B390 only, nine samples of eggs were taken in each stage of laying. A sample consisted of 30 eggs taken from each laying stage. The variables measured were shell weight (ShW), shell calcium (ShCa), albumen weight (AlbW), yolk weight (YoW), total protein in albumen (TPA1b), total protein in yolk (TPY0), and cholesterol in yolk (CholYo). When each egg was broken, the weights of the shell (ShW), albumen (AlbW), and the yolk (YoW) which had been carefully removed from the albumen were separately determined.

The first experiment was analysed as a 3 x 3 factorial design in which the first factor (A) was stage (age) of egg laying with three levels (a) 34-55 weeks (b) 56-96 weeks and (c) over 96 weeks. The second factor (B) was breed of layer chicken (a) 411 (b) Harco and (c) 399. The second experiment was considered as a two-way design. In both experiments, the data were subjected to analysis of variance and treatment means were compared by Duncan’s New Multiple Range Test (Steel and Torrie, 1960).

Table 2: Effects of Age and Strain of Layers on Serum Contents of Cholesterol, Calcium and Total Proteins in Chickens

<table>
<thead>
<tr>
<th>Age of layers (weeks)</th>
<th>Breed</th>
<th>Cholesterol (mg/100ml)</th>
<th>Calcium (mg/100ml)</th>
<th>Total protein (g/100ml)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1 (34-55)</td>
<td>B1 (411)</td>
<td>97.5&lt;sup&gt;bc&lt;/sup&gt;</td>
<td>21.0&lt;sup&gt;d&lt;/sup&gt;</td>
<td>6.2&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>B2 (Harco)</td>
<td>102.2&lt;sup&gt;d&lt;/sup&gt;</td>
<td>18.8&lt;sup&gt;de&lt;/sup&gt;</td>
<td>6.1&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>B3 (399)</td>
<td>89.5&lt;sup&gt;abc&lt;/sup&gt;</td>
<td>21.5&lt;sup&gt;d&lt;/sup&gt;</td>
<td>6.4&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>A2 (56-96)</td>
<td>B1 (411)</td>
<td>151.1&lt;sup&gt;d&lt;/sup&gt;</td>
<td>19.8&lt;sup&gt;de&lt;/sup&gt;</td>
<td>6.5&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>B2 (Harco)</td>
<td>76.3&lt;sup&gt;a&lt;/sup&gt;</td>
<td>15.1&lt;sup&gt;b&lt;/sup&gt;</td>
<td>6.1&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>B3 (399)</td>
<td>143.5&lt;sup&gt;d&lt;/sup&gt;</td>
<td>27.1&lt;sup&gt;c&lt;/sup&gt;</td>
<td>6.5&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>A3 (over 96)</td>
<td>B1 (411)</td>
<td>82.5&lt;sup&gt;ac&lt;/sup&gt;</td>
<td>16.6&lt;sup&gt;b&lt;/sup&gt;</td>
<td>6.3&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>B2 (Harco)</td>
<td>82.3&lt;sup&gt;a&lt;/sup&gt;</td>
<td>17.0&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>6.4&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>B3 (395)</td>
<td>81.7&lt;sup&gt;a&lt;/sup&gt;</td>
<td>18.9&lt;sup&gt;c&lt;/sup&gt;</td>
<td>6.3&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Overall mean and SEM*</td>
<td></td>
<td>100.72 ± 4.42</td>
<td>19.53 ± 0.65</td>
<td>6.30 ± 0.13</td>
</tr>
</tbody>
</table>

Means in the same column with the same superscript are not different (P > 0.05).

*SEM = Standard Error of Mean.
Table 3: Effect of Stage of Laying on the Weights and Biochemistry of Egg Shell, Albumen and Yolk of Strain 399

<table>
<thead>
<tr>
<th>Variables</th>
<th>34-53 weeks</th>
<th>54-96 weeks</th>
<th>Over 96 weeks</th>
<th>Overall x ± SE</th>
</tr>
</thead>
<tbody>
<tr>
<td>ShW</td>
<td>6.2&lt;sup&gt;a&lt;/sup&gt;</td>
<td>6.7&lt;sup&gt;a&lt;/sup&gt;</td>
<td>6.4&lt;sup&gt;a&lt;/sup&gt;</td>
<td>6.4 ± 0.32</td>
</tr>
<tr>
<td>ShCa</td>
<td>233.1&lt;sup&gt;a&lt;/sup&gt;</td>
<td>334.3&lt;sup&gt;b&lt;/sup&gt;</td>
<td>299.6&lt;sup&gt;b&lt;/sup&gt;</td>
<td>289 ± 0.92</td>
</tr>
<tr>
<td>AlbW</td>
<td>33.0&lt;sup&gt;a&lt;/sup&gt;</td>
<td>35.0&lt;sup&gt;a&lt;/sup&gt;</td>
<td>33.5&lt;sup&gt;a&lt;/sup&gt;</td>
<td>33.8 ± 1.49</td>
</tr>
<tr>
<td>YoW</td>
<td>16.2&lt;sup&gt;a&lt;/sup&gt;</td>
<td>24.7&lt;sup&gt;b&lt;/sup&gt;</td>
<td>22.1&lt;sup&gt;b&lt;/sup&gt;</td>
<td>20.9 ± 1.64</td>
</tr>
<tr>
<td>TPAlb</td>
<td>9.8&lt;sup&gt;a&lt;/sup&gt;</td>
<td>9.7&lt;sup&gt;a&lt;/sup&gt;</td>
<td>9.0&lt;sup&gt;a&lt;/sup&gt;</td>
<td>9.50 ± 0.68</td>
</tr>
<tr>
<td>TPYo</td>
<td>8.4&lt;sup&gt;a&lt;/sup&gt;</td>
<td>10.9&lt;sup&gt;a&lt;/sup&gt;</td>
<td>11.3&lt;sup&gt;a&lt;/sup&gt;</td>
<td>10.20 ± 1.36</td>
</tr>
<tr>
<td>CholYo</td>
<td>2019.1&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2147.5&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2383.8&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2183.42 ± 5.05 x 10&lt;sup&gt;4&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

Means with the same superscript within a row are not different (P > 0.05).
ShW = Shell weight; ShCa = Shell calcium; AlbW = Albumen weight; YoW = Yolk weight;
TPAlb = Total protein in albumen; TPYo = Total protein in yolk; CholYo = Cholesterol in yolk.

**Results**

Table 2 shows that in the first stage of laying (34-55 weeks) there was no significant (P>0.05) difference in either Chol or Ca concentrations among the three breeds. In the second stage (56-96 weeks), the Harco breed had a lower Chol and Ca and differed significantly (P<0.05) from strain SB411 and B390. In the third stage (over 96 weeks), serum Ca level was lowest in the SB411 strain and it differed (P<0.05) significantly from the level for the B390. The level of Chol and Ca but not TP in all the breeds differed (P<0.01) significantly with the stage of laying. In the second trial, Table 3 shows significant (P<0.05) replicate effect for ShCa and TPAlb and there was a significant (P<0.05) stage of laying effect on ShCa and YoW. Table 3 shows that ShCa and YoW at first stage (34-55 weeks) differed (P<0.05) from stages two and three.

**Discussion**

Serum cholesterol and calcium concentrations in each of the three breeds under study were found to differ significantly with the stage of laying of the chickens. These metabolites are in highest concentration in the serum of the 411 and 399 breeds in the second stage of laying (56-96 weeks) and lowest in the oldest age group (over 96 weeks), whereas in the Harco breed the metabolites are in highest concentration in the 34-55 weeks group and lowest in the 56-96 weeks group. Blood lipid concentrations, particularly cholesterol and fatty acid, in mature chickens have been reported to be affected by oestrogen (Kudzma et al., 1973; Akiba et al., 1983); by high cholesterol diet (Ho, 1976); and by breed differences (Hardy et al., 1962). The findings of this study concur with those of Hardy et al. (1962).

There seems to be no relationship between serum cholesterol levels and egg yolk cholesterol content. This is in support of similar reports by Fraps (1955) and Siddioni et al. (1974).

The pattern of change of cholesterol content of egg yolk (CholYo) with age of the chickens although it lacked significance, suggested that the older the bird the higher the cholesterol content of its egg yolk. Eggs and chickens were not usual components of the average Nigerian's diet a decade ago (Omololu and Olusanya, 1972) but since then the position has changed. Although eggs have high protein and phospholipid content (Long, 1971), their cholesterol content is also alarmingly high and this could cause high incidence of arteriosclerosis and cardiovascular accidents in Nigeria as has been reported in western countries (Keys, 1975).

The recent egg-eating public in Nigeria and some other parts of Africa, therefore, should be made aware of the risks associated with their over consumption.

The serum cholesterol concentrations of the chickens were far lower than that of the eggs but an important finding was that the older the chicken the lower the blood cholesterol. Whether the cholesterol content of the tissues, which are the consumable parts of the chicken follows the same pattern needs to be investigated.
Levels of serum calcium in layers are known to be under hormonal control (oestrogen, 1,25 dihydroxy cholecalciferol and parathormone) and are also affected by the calcium content of the diet (Horton-Smith and Amoroso, 1966; Bikle et al., 1975). This study also showed the existence of breed differences on serum Ca.

The shell calcium content (ShCa), also varies significantly with the age of the layers. It was highest in the 56-96 weeks group. The mobilisation and secretion of calcium from the blood for shell formation is known to be under the influence of oestrogen in cooperation with parathormone (Gutovska et al., 1943) and calcitonin (Hirsch, 1971).

Breed differences in egg size and weight are well known (Roberts and Hunter, 1934) however only yolk (YoW) showed significant breed differences in this study.

Plasma total protein levels, which are more directly dependent on diet and less on hormonal influences showed no breed or age differences, but albumen total protein (AlbTP) which is under oestrogen and progesterone control (Nalbandov, 1958) showed significant age differences. It was highest in the youngest age group (34-55 weeks).

References

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Some Haematological and Biochemical Values of Turkeys in Ibadan

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Summary

Whole blood plasma and sera from 40 apparently healthy adult White England turkeys kept in Ibadan, Nigeria were analysed to determine some of their haematological and biochemical values. Parameters investigated were erythrocytes, PCV, Hb and erythrocyte indices. Sodium, potassium, calcium, total protein, albumin, globulin, glucose, alkaline phosphatase, serum glutamic oxaloacetic transaminase and serum glutamic pyruvic transaminase. Variations were obtained in the electrolyte concentrations. Serum enzymes showed wide variations especially with alkaline phosphatase. SGOT value was higher in turkeys than the reported values in chicken kept in the temperate and in the tropical environment. The globulin value of 60.1% was higher than the albumin value.

Introduction

Very little is known about basic physiological values in turkeys kept in Nigeria. The few reported values are those obtained in turkeys kept in the temperate environment (Lynch and Stafseth, 1953). Differences have been reported in haematological and biochemical values in some breeds of domestic animals kept in the tropical environment as against the values obtained in temperate climates (Oduye and Adadevoh, 1976).

Turkey raising is not as popular as domestic fowl production among Nigerian livestock farmers. This is likely due to the fact that turkeys are more expensive than chickens, and possibly the high mortality rate often encountered during their production. Various factors could be attributed to this relatively high mortality rate such as environmental influences, managerial practices, nutritional factors, etc. These factors result in the lowering of their body resistance to the prevalent high infection rate in the tropics. In order to critically assess this situation there is the need to establish the baseline values for haematological and biochemical parameters in turkeys kept in this environment. This is important in assessing their health status and for diagnostic purposes in disease conditions. Moreover, most of the plasma or serum biochemical values had been found to vary with different laboratories as analytical procedure, breed, age, physiological state and dietary intake affect them; it was therefore suggested (Dimopoulus, 1970) that each clinical laboratory establish values which are accepted as normal for each species of animal.

Materials and Methods

Forty apparently healthy adult White England turkeys of both sexes kept intensively at a private farm in Ibadan were used for this investigation. They were 9 months old and were imported into Nigeria at day-old. The turkeys were fed an adequate quantity of feed whose protein concentration was 25%. Fresh water and vitamin supplements were available ad libitum.

From each turkey, 5ml of blood was withdrawn from the wing vein into a universal bottle using ethylenediamine tetraacetic acid (EDTA) as anticoagulant. Another sample (5ml) was taken into a universal bottle without anticoagulant. From the former samples were estimated the erythrocyte population using the haemocytometer counting technique; haematocrit (PCV) using the microhaematocrit method; haemoglobin (Hb) value using the cyanmethaemoglobin method while the erythrocyte indices — the mean corpuscular volume (MCV), the mean corpuscular haemoglobin concentration (MCHC) and the mean corpuscular haemoglobin (MCH) were calculated as described by Schalm, Jain and Carroll (1975). Plasma was separated from the samples by centrifuging the anticoagulated blood at 3,000 rev/min for 20 minutes and stored at — 20°C until analysis.

From the plasma, the electrolyte concentrations — sodium (Na⁺), potassium (K⁺) and calcium (Ca⁺⁺) were estimated.
Na⁺ and K⁺ estimations were obtained using the standard flame photometer and Ca²⁺ estimation by chelation method. The plasma total protein, albumin and globulin values were estimated using Ames Blood analyser model 6300 with their respective reagent kits.

Serum was separated from samples without anticoagulant, stored at -20°C and later analysed for the glucose level and alkaline phosphatase on Ames Blood analyser with their respective reagent kits. Serum transaminases — glutamic oxaloacetic transaminase (SGOT) and glutamic pyruvic transaminase (SGPT) were determined with Ames Blood analyser using SGOT and SGPT reagent kits. The tests were based on pyruvate formation and its reaction within vanillin to give a yellow colour (Trinder and Kirkland, 1967).

### Results and Discussion

The results are presented in Tables 1 and 2. Table 1 shows the mean erythrocyte count, PCV, Hb and the erythrocyte indices — MCV, MCHC and MCH. The number of erythrocytes in circulation ranged from 2.30 to 4.10 million/mm³ in the adult male turkeys and 2.0 to 2.40 million/mm³ in the adult female turkeys. Male turkeys therefore have more erythrocytes than females. The PCV was higher in the adult male than the adult female; 36-45% in the male and 35-41% in the female. The trend was similar with the Hb values 11.1 - 14.9 g/100ml in the male and 10.7 - 13.2 g/100ml in the female. With the erythrocyte indices, the MCV and MCH were higher in the adult female turkeys than the male.

### Table 1: Mean Blood Values (± SD) in Normal White England Turkeys in Ibadan

<table>
<thead>
<tr>
<th>Sex</th>
<th>No. sampled</th>
<th>Rbc (x10⁹/mm³)</th>
<th>PCV (%)</th>
<th>Hb (g/100ml)</th>
<th>MCV (µl)</th>
<th>MCHC (%)</th>
<th>MCH (pg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>15</td>
<td>2.57 ± 0.57</td>
<td>39.45 ± 2.34</td>
<td>12.95 ± 1.03</td>
<td>157.1 ± 29.17</td>
<td>32.9 ± 3.61</td>
<td>51.9 ± 9.4</td>
</tr>
<tr>
<td>Female</td>
<td>25</td>
<td>2.16 ± 0.17</td>
<td>38.5 ± 2.22</td>
<td>11.65 ± 0.80</td>
<td>177.3 ± 14.3</td>
<td>30.3 ± 2.19</td>
<td>53.96 ± 4.6</td>
</tr>
</tbody>
</table>

### Table 2: Biochemical Values in Normal White England Turkeys Kept in Ibadan

<table>
<thead>
<tr>
<th>Test/unit</th>
<th>Range</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plasma sodium (mEq/litre)</td>
<td>34 - 72.5</td>
<td>58.82</td>
<td>± 8.49</td>
</tr>
<tr>
<td>Plasma potassium (mEq/litre)</td>
<td>5.4 - 16.0</td>
<td>11.87</td>
<td>± 2.84</td>
</tr>
<tr>
<td>Plasma calcium (mg/ml)</td>
<td>3.19 - 9.92</td>
<td>4.34</td>
<td>± 1.36</td>
</tr>
<tr>
<td>Plasma total protein (g/100ml)</td>
<td>2.87 - 5.60</td>
<td>3.93</td>
<td>± 0.62</td>
</tr>
<tr>
<td>Plasma albumin (g/100ml)</td>
<td>1.08 - 2.12</td>
<td>1.55</td>
<td>± 0.32</td>
</tr>
<tr>
<td>Plasma globulin (g/100ml)</td>
<td>1.36 - 3.48</td>
<td>2.36</td>
<td>± 0.50</td>
</tr>
<tr>
<td>Serum glucose (mg/100ml)</td>
<td>200 - 290</td>
<td>249.8</td>
<td>± 23.84</td>
</tr>
<tr>
<td>Serum alkaline phosphatase (i.u.)</td>
<td>65 - 120</td>
<td>103.5</td>
<td>± 15.6</td>
</tr>
<tr>
<td>Serum glutamic oxaloacetic transaminase (Karmen unit)</td>
<td>400 - 1120</td>
<td>772.5</td>
<td>± 240.2</td>
</tr>
<tr>
<td>Serum glutamic pyruvic transaminase (Karmen unit)</td>
<td>6 - 18</td>
<td>10.7</td>
<td>± 2.87</td>
</tr>
</tbody>
</table>
Statistical analysis using student's t-test showed that the rbc values of adult male turkeys are significantly higher than those of the females \( (P>0.01, <0.05) \). Other parameters, apart from the erythrocyte population are not significantly affected by sex. The sex differences in erythrocyte population was similarly observed in the domestic fowl (Olson, 1965) and it was thought to be due to the influence of the male hormones; although Sturkie and Textor (1960) could not confirm this in an earlier study with chickens.

Table 2 shows the mean values of the electrolytes (Na\(^+\), K\(^+\) and Ca\(^{++}\)), total protein, albumin and globulin in the adult turkey plasma. Values obtained for the serum glucose level, alkaline phosphatase and serum transaminases (SGOT and SGPT) are included.

The plasma electrolytes in turkeys kept in this environment were Na\(^+\) 58.82 ± 8.49 meq/litre, K\(^+\) 11.87 ± 2.84 meq/litre and Ca\(^{++}\) 4.34 ± 1.36 mg/ml. The Na\(^+\) concentration obtained was a little lower than the value obtained in imported chickens kept in this environment (unpublished). However, K\(^+\) concentration was higher.

It has been reported that attempts to use changes observed in the composition of the plasma proteins for specific diagnosis of disease have not been successful because many diseases and physiological aberrations produce similar changes in the plasma protein profile (Dimoupolous, 1970). However, major differences in any of the components are a useful adjunct of pathological processes taking place. Lynch and Stafseth (1953) obtained 4.40 g/100ml for total protein in the adult Broad-breasted Bronze turkey toms in the U.S. They obtained 66.5\% for the albumin concentration and globulins having the rest. The reverse was true in our study, the globulins value was higher — 60.1\%, and albumin, 39.4\%. The decrease in albumin with an increase in globulins concentration may be due to an increase in the gammaglobulins fraction possibly resulting from an infection.

The serum glucose of 249.8 ± 23.84 mg/100ml was considered high when compared with 130-290 mg/100ml whole blood in laying and non-laying chicken (Swenson, 1970). This may be due to the fact that the turkeys were not subjected to the standard 24-hour fast prior to sampling as suggested for the non-ruminant and even young ruminant domestic animals (Kaneko, 1970).

On serum enzymes, a wide range of serum alkaline phosphatase values was obtained. This is similar to the wide range of serum alkaline phosphatase activities in some of the domestic animals (Allcroft and Folley, 1941 in cattle and sheep). The range of SGOT value obtained in this strain of turkey was 400-1120 Karmen units with an average of 772.5 ± 240.2 Karmen units. Cornelius et al. (1959) reported SGOT value of 370 ± 186 units in chicken. Olowookorun et al. (1979) obtained 157.5 ± 26.8 Karmen units in the male guinea-fowl and 92.5 ± 14.79 Karmen units in the male Nigerian chicken. Our results reveal a higher SGOT activity in turkeys than other avian species. In the domestic chicken and guinea-fowl, the values reported were 11.25 ± 4.14 K.U. and 9.37 ± 5.69 K.U. respectively (Olowookorun et al., 1979). These enzymes (SGPT and serum alkaline phosphatase) have been shown to be effective in diagnosing liver diseases (Hoe and Jabara, 1967). The use of SGPT test is confined to smaller animal species as large animals contain little hepatic GPT activity (Cornelius, 1970). Elevations in the SGOT activity have been reported to be associated with various diseases involving tissue necrosis and hereditary muscular dystrophy (Blincoe and Dye, 1958).

Acknowledgements

The authors are grateful to the technical staff in the Department of Veterinary Physiology and Pharmacology and Miss D.E. Udofia of the Department of Veterinary Medicine for their technical assistance.

References


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Epidemiology of Newcastle Disease in Kenya

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Summary

The epidemiology and ecology of Newcastle disease was studied by analysis of data from the annual reports of the Kenya veterinary department. The disease was found to be widely distributed throughout the country. Analysis of positive diagnoses showed a trend with three peaks in a year. The level of the disease declined in 1958 to 1959 and in 1972 to 1973 with the introduction of the killed vaccine and the F strain vaccine respectively.

Introduction

Newcastle disease (ND) is one of the major economically important diseases of poultry in the world. Seasonal prevalence of the disease has been recognized. Brandy et al. (1964) reported that in temperate countries the disease is more prevalent during fall and winter tending to subside during the spring and to disappear largely during the summer.

In contrast, Kaschula (1961) reported that in the tropics, the disease is more prevalent during the warmer months. Scott et al. (1956) described the disease as it occurred in Kenya and suggested that ND was introduced into Kenya from Asia. The purpose of this work was to study some aspects of the epidemiology of Newcastle disease in Kenya.

Materials and Methods

Data on the outbreaks and positive diagnoses of Newcastle disease as reported monthly and annually by the Kenya Veterinary Department, Ministry of Agriculture and Livestock Development, was appropriately analysed.

For the laboratory diagnosis of Newcastle disease virus, homogenates of liver, spleen, proventriculus and trachea were prepared. These were centrifuged at 1000 g for 15 minutes and the supernatant fluids used to inoculate 11-day old embryonated chicken eggs through the allantoic route. The eggs were further incubated for 3-5 days. Many of the embryonated eggs were killed in this period. Those that were still alive on day 5, were chilled. The allantoic fluid was harvested and tested for haemagglutinating activity.

Any virus isolates were identified with specific antiserum in the haemagglutination-inhibition test by the method of Allan et al. (1978).

Results

The frequency of Newcastle disease outbreaks and diagnoses is shown in Figure 1.

![Figure 1: Frequency of Newcastle disease outbreaks and diagnoses in Kenya (1955 - 1980).](image-url)

Although data regarding the number of outbreaks for the periods 1935 to 1956 and 1972 to 1980 was not available, individual outbreaks were reported. Newcastle disease was first encountered in Kenya in 1935 on Mombasa Island with another outbreak...
occurring in 1937. In 1939, several outbreaks occurred in Nairobi district but official records contain no reference on the number of cases diagnosed from these outbreaks. Thereafter the disease was not identified in Kenya until 1955 when several cases were diagnosed from widely scattered areas of the country. The number of cases diagnosed increased considerably in 1957 but the numbers subsequently decreased progressively until 1965 after which there was a dramatic rise.

The trend of a 3-month moving average of the positive diagnoses only for the period 1967 to 1980 (Fig. 2) shows an apparent rise towards 1972 after which there was a downward trend towards 1980. On the other hand, when the annual trend of positive diagnoses (pooled for months) for the same period (1967 to 1980) was examined, three peaks were observed (Fig. 3). The peaks occurred in March-April, June-July and October-November periods of the year.

Newcastle disease outbreaks were widely

Table 1: Distribution of Newcastle Disease Outbreaks by Provinces (1957-1971)

<table>
<thead>
<tr>
<th>Year</th>
<th>Year</th>
<th>Year</th>
<th>Year</th>
<th>Year</th>
<th>Year</th>
<th>Year</th>
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<th>Year</th>
<th>Year</th>
<th>Year</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nyanza</td>
<td>4</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>E*</td>
<td>1</td>
<td>1</td>
<td>E</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>6</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Rift Valley</td>
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<td>3</td>
<td>14</td>
<td>2</td>
<td>5</td>
<td>10</td>
<td>13</td>
<td>E</td>
<td>13</td>
<td>14</td>
<td>23</td>
<td>23</td>
<td>32</td>
<td>7</td>
</tr>
<tr>
<td>Southern</td>
<td>—</td>
<td>2</td>
<td>2</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
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<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Central</td>
<td>63</td>
<td>16</td>
<td>29</td>
<td>22</td>
<td>21</td>
<td>6</td>
<td>23</td>
<td>E</td>
<td>3</td>
<td>8</td>
<td>5</td>
<td>9</td>
<td>11</td>
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<td>7</td>
<td>E</td>
<td>2</td>
<td>E</td>
<td>E</td>
<td>E</td>
<td>E</td>
<td>E</td>
<td>1</td>
<td>1</td>
<td>8</td>
<td>2</td>
</tr>
<tr>
<td>Northern</td>
<td>—</td>
<td>1</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>E</td>
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</tr>
<tr>
<td>Western</td>
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<td>6</td>
</tr>
<tr>
<td>Eastern</td>
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<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>E</td>
<td>—</td>
<td>15</td>
<td>—</td>
<td>6</td>
<td>9</td>
<td>1</td>
</tr>
<tr>
<td>Nairobi</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>9</td>
<td>—</td>
<td>6</td>
<td>—</td>
</tr>
<tr>
<td>North Eastern</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>1</td>
<td>1</td>
<td>3</td>
</tr>
</tbody>
</table>

E: The disease was reported as being endemic
Epidemiology of Newcastle Disease in Kenya 251

Figure 3: Annual trend of Newcastle disease positive diagnoses in Kenya (pooled for months, 1967-1980).

reported from all provinces in the country and distributed throughout Kenya for the period 1957 to 1971 (Table 1). The disease was for the period 1957 to 1963 most of the outbreaks were reported from Central province. However, there was a decrease in the number of outbreaks reported from Central province from 1963 onwards while those reported from Rift Valley province increased in the same time.

Discussion

Newcastle disease occurred with a greater frequency during the cold and wet months of the year. These findings differ from those of Kaschula (1961) who reported that the disease occurred with a greater frequency during the warm weather in the tropics. Since Kaschula (1961) did not provide supporting data, it is difficult to give a reason for the discrepancy. However, results of the present study agree with those of Brandly et al. (1946) who found that the disease was more prevalent during fall and winter in temperate countries. Factors involved in the seasonal prevalence of the disease have not been determined. However, the virus has been shown to survive longer at low temperatures than at high temperatures (Olesiuk, 1951), and at higher relative humidities than at low relative humidity (Boyd and Hanson, 1958). Low temperatures and high relative humidities during the cold and wet seasons could be important factors in this regard.

Newcastle disease was found to be widely distributed throughout the country. Although the disease was reported from every province of the country, most of the outbreaks were reported from Central and Rift Valley provinces where most of the commercial flocks were concentrated. The decline in the number of outbreaks reported from Central province from 1963 onwards could have been due to the reorganization of administrative boundaries. At this time, Nairobi area was separated from Central province and several districts which had previously been in Nyanza province were moved to Rift Valley province.

Despite the use of both the killed and live vaccines, the prevalence of the disease did not decline to significantly low levels. This indicates that there must be other factors which contributed to this. Possibly the vaccine was not used to cover a large enough poultry population and that the farmers may not have been very aware of the usefulness of the vaccination procedure. It is therefore suggested that a country-wide mass vaccination of all birds be effected, coupled with proper education of the farmers by extension workers. It is also possible that variations in the virus strains present in the country occurred and that the immunity induced by the vaccine strains did not cover the wild type strains fully. An assessment of variability in the locally isolated strains should answer this question.

References


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null
The Pathogenicity and Pathology of a Nigerian Isolate of Infectious Bursal Disease Virus in Chickens

Clinicopathological Manifestations of the Experimental Disease

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Summary

A flock of 200 susceptible broilers at 5 weeks of age was inoculated intraocularly with a 20% bacteria-free bursal suspension containing a local Nigerian isolate of infectious bursal disease (IBD) virus (IBDV) which was found to have a bursal lesion 50 (BL50) titre of $10^{4.9}/0.5$ ml. Clinical signs were mainly depression and diarrhoea and lasted from the third to the seventh day post-inoculation (PI).

At necropsy bursal enlargement was observed on the first day PI but atrophy was quite evident by the sixth day PI. Kidney was also enlarged by the first day PI but by the seventh day PI there was no renal lesion in sacrificed birds. The thymus and spleen were also enlarged on the first day PI and by the fifth day PI they were atrophic. Hepatomegaly was evident on the second day PI and increased in severity up to the ninth day PI.

While the BL50 titre of the isolate appears to be comparatively high, some of the clinical signs already described for IBD were not observed.

Introduction

Infectious bursal disease (IBD) was first described by Cosgrove (1962) in Gumboro area of Southern Delaware, United States of America. Since then the clinical and pathological manifestations of the disease produced by different strains of IBD virus (IBDV) have been reported from many parts of the world by other workers (Helmboldt and Garner, 1964; Winterfield and Hitchner, 1964; Giron, 1969; Cho and Edgar, 1972; Hirai et al., 1973). But some of their findings are not in agreement with what has been observed in many field outbreaks of IBD in Nigeria (Ojo et al., 1973; Onunkwo, 1975, 1978; Okoye and Uzoukwu, 1981, 1982). It could be that the manifestations of these field outbreaks were affected by such factors as nutrition, management and subclinical intercurrent infections. This project was therefore undertaken to study the clinical and pathological characteristics of IBD produced by a local Nigerian isolate of IBDV under controlled experimental conditions. The persistence of the virus, appearance of precipitins and the histopathogenesis in the lymphoid organs of the infected chickens are already described in separate publications (Okoye, 1984; Okoye and Uzoukwu, 1984; Okoye, 1985).

Materials and Methods

Flock History

The chickens used in this study were 320 Star Cross broilers obtained from IBD non-vaccinated dams at day-old. They were randomly divided into three groups comprising Group A 200 chicks, Group B 60 chicks and Group C 60 chicks. The birds were not inoculated against any disease and rearing was by deep litter system. Separate attendants and stores were used for the groups which had no history of any disease outbreaks before the day of experimental infection with IBDV.

The Virus

Bursae of chickens collected from confirmed field outbreaks of IBD in Nigeria (Okoye and Uzoukwu, 1982) were weighed and ground in mortar with pestle and sand. Four times the equivalent volume of phosphate buffered saline (PBS) was added to make a 20% bursal suspension. The mixture was centrifuged at 3000 rev/min for 30 minutes and the supernatant was passed through a 220 nm millipore filter paper. The suspension was checked for sterility using blood agar, thioglycollate, nutrient and Sabouraud broths.
Inoculation
A total of 0.05 ml of the bacteria-free suspension was administered intraocularly to each bird in Group A at the age of 5 weeks. The suspension was also at the same time used for virus titration in Group C birds. Group B birds which served as controls were only given 0.05 ml of the PBS intraocularly.

Virus Titration
Tenfold serial dilutions of the virus suspensions were made from $10^{-1}$ to $10^{-6}$. Each of the dilutions was administered intraocularly to a batch of 10 Group C chickens at 5 weeks of age at the rate of 0.05 ml per bird. Each batch was kept in a different cage and reared separately for 3 days post inoculation (PI). All were sacrificed and the bursae were examined grossly and histopathologically for IBD lesions. The bursal lesion 50 (BL50) titre was calculated by the method of Reed and Muench (1938) as shown in Table 1.

Clinical Signs and Necropsy
Infected birds (Group A) and control birds (Group B) were observed three times a day for clinical signs and cloacal temperatures were taken twice a day for 8 days. Five infected and two control birds were sacrificed daily for 15 days PI and on day 81 PI. Along with the dead ones, they were examined for gross pathological lesions.

Serology
Blood samples were collected from 20 birds in Group A, 6 in Group B and also 6 in Group C immediately before IBDV inoculation. Five infected group A chickens and two control Group B chickens were sacrificed daily for 15 days PI and blood samples were collected from all of them. Sera were harvested, inactivated at 56°C for 30 minutes in a water bath and assayed for IBD precipitins in agar gel diffusion precipitation test (AGDT) as already described by Okoye and Uzoukwu (1981).

Results

Clinical Signs
The infected birds (Group A) looked normal on days 1 and 2 PI. But on day 3 there was marked reduction in feed and water consumption. Most of the birds were drowsy, lying down, had ruffled feathers and greenish diarrhoea. Some had dropped wings. First mortalities were on day 4 PI and involved five birds while many were prostrate. Some hid their heads in their wings or hid themselves in dark corners. By day 7 PI, marked recovery was noticed and few birds were still drowsy

Table 1: Calculation of Bursal Lesion 50 (BL50) Titre of the IBD Virus Suspension

<table>
<thead>
<tr>
<th>Log$_{10}$ of virus dilution</th>
<th>Ratio of birds showing IBD lesions</th>
<th>Response</th>
<th>Accumulated values</th>
<th>Percentage lesions</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Lesion</td>
<td>No lesion</td>
</tr>
<tr>
<td>10$^{-1}$</td>
<td>10/10</td>
<td>10</td>
<td>0</td>
<td>33</td>
</tr>
<tr>
<td>10$^{-2}$</td>
<td>9/10</td>
<td>9</td>
<td>1</td>
<td>23</td>
</tr>
<tr>
<td>10$^{-3}$</td>
<td>6/10</td>
<td>6</td>
<td>4</td>
<td>14</td>
</tr>
<tr>
<td>10$^{-4}$</td>
<td>5/10</td>
<td>5</td>
<td>5</td>
<td>8</td>
</tr>
<tr>
<td>10$^{-5}$</td>
<td>3/10</td>
<td>3</td>
<td>7</td>
<td>3</td>
</tr>
<tr>
<td>10$^{-6}$</td>
<td>0/10</td>
<td>0</td>
<td>10</td>
<td>0</td>
</tr>
</tbody>
</table>

Proportionate distance = 

\[
\frac{100 - 0}{100 - 50} = \frac{50}{50} = 1.00
\]

Bursal lesion 50 titre = $10^{-6}/0.05$ ml

Bursal lesion 50 titre = $10^{-6}/5$ ml
and dull. Complete recovery occurred on day 8 PI. The mortalities recorded are shown in Table 2.

<table>
<thead>
<tr>
<th>Day PI</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mortality</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>5</td>
<td>10</td>
<td>3</td>
<td>1</td>
<td>0</td>
</tr>
</tbody>
</table>

Total mortality = 19; mortality rate = 9.5%; PI = post-infection.

Increase in average body temperature of 0.5°C and 1.0°C above the control occurred on days 1 and 2 PI respectively. The lowest temperature in moribund birds was 38.0°C. The daily average temperatures of both infected and control birds are shown in Table 3. A total of 19 birds died.

<table>
<thead>
<tr>
<th>Day PI</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>43.1</td>
<td>43.0</td>
<td>43.0</td>
<td>43.1</td>
<td>43.1</td>
<td>43.0</td>
<td>43.2</td>
<td>43.0</td>
<td></td>
</tr>
<tr>
<td>Infected</td>
<td>43.0</td>
<td>43.5</td>
<td>44.0</td>
<td>42.5</td>
<td>40.0</td>
<td>41.5</td>
<td>43.0</td>
<td>43.0</td>
<td>43.0</td>
</tr>
</tbody>
</table>

Gross Necropsy Lesions
Markedly enlarged bursa (Fig. 1) was covered externally by some transparent gelatinous matter on day 1 PI. The serosal surface was longitudinally striated. By day 2 PI the mucosal surfaces were haemorrhagic or congested and the bursal cavity contained yellow slimy exudate. Regression in bursal size and the presence of bloody fluid and caseous plugs inside the cavity occurred on day 4 PI. Bursal atrophy (Fig. 2) was prominent by day 6 PI, but the serosal striation, congested mucosa and slimy exudates still persisted. Atrophy was the only lesion that persisted till the last observation on day 81 PI. The daily average values obtained for bursal weights, bursal percent of carcass weights, bursal horizontal diameter for the control and the infected birds are shown in Table 4. Changes in the bursal size corresponded with the changes in weight. Kidneys were enlarged and congested by day 1 PI. By day 3 PI haemorrhages and distension of the renal lobules were observed. The kidney was brownish or pale red. On day 7 PI sacrificed birds had no gross renal lesions but the one that died on that day showed enlargement and congestion.

The spleen was enlarged and more reddish than the control on day 1 PI (Fig. 1). Grey or whitish spots appeared on the serosal surface the following day. Splenic enlargement was reduced on days 3 and 4 PI and by day 5 PI, atrophy was evident and persisted to day 15 PI (Fig 2). The daily average weights of the spleen and its percent of carcass weight for the control and infected birds are shown in Table 4.

Figure 1: Enlarged thymus (T), spleen (S) and bursa (B) of infected bird (E) compared with those of the control (C) on day 2 PI.

Figure 2: Enlarged liver (L), atrophic bursa (B), spleen (S) and thymus (T) of infected bird (E) compared with those of the control (C) 7 days PI.
Table 4: Changes in Weight and Size of the Bursa, Spleen and Liver from Control Birds and Those Experimentally Infected with IBD Virus

<table>
<thead>
<tr>
<th>Day PI</th>
<th>Type</th>
<th>Wt of carcass (g)</th>
<th>Wt of bursa (g)</th>
<th>Bursa % of carcass wt</th>
<th>Diameter of bursa (mm)</th>
<th>Wt of spleen (g)</th>
<th>Spleen % of carcass wt</th>
<th>Wt of liver (g)</th>
<th>Liver % of carcass wt</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Control</td>
<td>291.5</td>
<td>1.0</td>
<td>0.34</td>
<td>18</td>
<td>0.5</td>
<td>0.17</td>
<td>8.0</td>
<td>2.74</td>
</tr>
<tr>
<td></td>
<td>Infected</td>
<td>359.1</td>
<td>2.0</td>
<td>0.56</td>
<td>26</td>
<td>1.0</td>
<td>0.28</td>
<td>10.0</td>
<td>2.88</td>
</tr>
<tr>
<td>2</td>
<td>Control</td>
<td>314.5</td>
<td>1.0</td>
<td>0.32</td>
<td>16</td>
<td>0.5</td>
<td>0.16</td>
<td>9.0</td>
<td>2.86</td>
</tr>
<tr>
<td></td>
<td>Infected</td>
<td>419.6</td>
<td>1.9</td>
<td>0.45</td>
<td>26</td>
<td>2.1</td>
<td>0.50</td>
<td>13.5</td>
<td>3.22</td>
</tr>
<tr>
<td>3</td>
<td>Control</td>
<td>255.5</td>
<td>1.2</td>
<td>0.47</td>
<td>17</td>
<td>0.2</td>
<td>0.08</td>
<td>7.8</td>
<td>3.05</td>
</tr>
<tr>
<td></td>
<td>Infected</td>
<td>286.3</td>
<td>2.2</td>
<td>0.79</td>
<td>28</td>
<td>0.4</td>
<td>0.14</td>
<td>11.2</td>
<td>3.91</td>
</tr>
<tr>
<td>4</td>
<td>Control</td>
<td>301.5</td>
<td>1.1</td>
<td>0.36</td>
<td>19</td>
<td>0.2</td>
<td>0.07</td>
<td>9.5</td>
<td>3.15</td>
</tr>
<tr>
<td></td>
<td>Dead</td>
<td>299.5</td>
<td>0.5</td>
<td>0.19</td>
<td>11</td>
<td>0.3</td>
<td>0.12</td>
<td>11.3</td>
<td>4.43</td>
</tr>
<tr>
<td></td>
<td>Killed</td>
<td>310.2</td>
<td>0.9</td>
<td>0.29</td>
<td>16</td>
<td>0.4</td>
<td>0.13</td>
<td>11.5</td>
<td>3.70</td>
</tr>
<tr>
<td>5</td>
<td>Control</td>
<td>346.0</td>
<td>1.2</td>
<td>0.35</td>
<td>18</td>
<td>0.5</td>
<td>0.14</td>
<td>9.8</td>
<td>2.83</td>
</tr>
<tr>
<td></td>
<td>Dead</td>
<td>412.4</td>
<td>0.6</td>
<td>0.15</td>
<td>11</td>
<td>0.4</td>
<td>0.10</td>
<td>14.5</td>
<td>3.52</td>
</tr>
<tr>
<td></td>
<td>Killed</td>
<td>284.7</td>
<td>0.7</td>
<td>0.25</td>
<td>13</td>
<td>0.3</td>
<td>0.11</td>
<td>12.8</td>
<td>4.50</td>
</tr>
<tr>
<td>6</td>
<td>Control</td>
<td>300.5</td>
<td>1.0</td>
<td>0.33</td>
<td>16</td>
<td>0.5</td>
<td>0.17</td>
<td>9.0</td>
<td>3.00</td>
</tr>
<tr>
<td></td>
<td>Dead</td>
<td>276.5</td>
<td>0.4</td>
<td>0.14</td>
<td>8</td>
<td>0.3</td>
<td>0.11</td>
<td>11.5</td>
<td>4.16</td>
</tr>
<tr>
<td></td>
<td>Killed</td>
<td>254.5</td>
<td>0.5</td>
<td>0.10</td>
<td>9</td>
<td>0.3</td>
<td>0.12</td>
<td>12.5</td>
<td>4.91</td>
</tr>
<tr>
<td>7</td>
<td>Control</td>
<td>392.6</td>
<td>1.1</td>
<td>0.28</td>
<td>18</td>
<td>0.8</td>
<td>0.20</td>
<td>11.5</td>
<td>2.93</td>
</tr>
<tr>
<td></td>
<td>Dead</td>
<td>421.6</td>
<td>0.5</td>
<td>0.12</td>
<td>8</td>
<td>0.4</td>
<td>0.09</td>
<td>17.8</td>
<td>4.22</td>
</tr>
<tr>
<td></td>
<td>Killed</td>
<td>301.0</td>
<td>0.6</td>
<td>0.20</td>
<td>11</td>
<td>0.2</td>
<td>0.07</td>
<td>13.8</td>
<td>4.58</td>
</tr>
<tr>
<td>8</td>
<td>Control</td>
<td>207.3</td>
<td>0.6</td>
<td>0.29</td>
<td>11</td>
<td>0.7</td>
<td>0.34</td>
<td>8.0</td>
<td>3.86</td>
</tr>
<tr>
<td></td>
<td>Infected</td>
<td>331.2</td>
<td>0.4</td>
<td>0.12</td>
<td>6</td>
<td>0.3</td>
<td>0.09</td>
<td>14.6</td>
<td>4.41</td>
</tr>
<tr>
<td>9</td>
<td>Control</td>
<td>296.5</td>
<td>1.0</td>
<td>0.34</td>
<td>16</td>
<td>0.6</td>
<td>0.20</td>
<td>9.1</td>
<td>3.07</td>
</tr>
<tr>
<td></td>
<td>Infected</td>
<td>306.6</td>
<td>0.4</td>
<td>0.13</td>
<td>7</td>
<td>0.2</td>
<td>0.07</td>
<td>12.9</td>
<td>4.21</td>
</tr>
</tbody>
</table>

Hepatomegaly was evident on day 2 PI and this increased in severity up to day 9 PI. Some of the livers were dark red or brown while others were pale. The daily average weight of the liver and liver percent of the carcass weight of control and infected birds are shown in Table 4.

The thymus was enlarged (Fig. 1) on day 1 PI. Some were congested and few haemorrhagic. By day 5 PI, the thymus was greatly reduced in size and this persisted till day 15 PI (Fig. 2). The thymus had regressed by day 81 PI.

Haemorrhages in the muscles of the chest and thigh were not observed until day 3 PI and occurred in all the infected sacrificed birds. By day 6 PI, the lesions became less severe and were found in only few of the birds. No muscle lesions were seen from day 7 PI onwards.

Haemorrhages on the mucosal surface of the proventriculus-gizzard junction were seen on days 4-6 PI while haemorrhagic enteritis affecting mainly the duodenum was very prominent from days 3 to 7 PI.

Lesions in dead birds were more severe than in those sacrificed on the same day PI. Control birds had no significant lesion throughout the experiment.

**Serology**

No precipitation lines were obtained in AGDT against any of the sera collected from the three groups just before IBDV inoculation. Positive results with sera from infected chickens were first obtained on day 7 PI. Sera from control chickens were negative.
Discussion

The results of the sera assay for IBDV precipitins in AGDT showed that the birds used in this study were free from detectable IBD precipitating antibody before the IBDV inoculation. This test was necessary because even though the birds came from IBD-nonvaccinated dams, subclinical IBD in the dams or in the experimental birds could have produced some antibodies that might interfere with the results of this experiment.

The BL₀₅₀ titre of 10⁴·⁷/0·₅ ml obtained in this case appeared to be higher than 10¹·₅/ml and 10¹·₆⁷/ml obtained by Giambroone (1979) and Henry et al. (1980) respectively using strains of IBDV obtained from Edgar and Cho, Auburn University Agricultural Experiment Station, Auburn. This high BL₀₅₀ titre obtained with a local Nigerian isolate indicates that the isolate may be comparatively more infective. This may be the reason why IBD has occurred in very young chicks of 9 days old (Onunkwo, 1978) and in older chickens of 16-20 weeks old (Okoye and Uzoukwu, 1981) in Nigeria. It could also be responsible for the high mortalities of up to 43·₈% (Onunkwo, 1975) and 33·₅% (Okoye and Uzoukwu, 1982) reported in field outbreaks of IBD in Nigeria.

The appearance of the clinical signs of IBD in this experiment on day 3 PI is similar to the findings of Hirai et al. (1973). But Cho and Edgar (1972) observed such signs within 24 to 78 hours PI, while Kaufers and Weiss (1976) using the intra-bursal route produced clinical signs by 12 hours PI and 24 hours PI after oral infection. These differences in time may be due to such factors as the dose of inoculum, route of infection, age, immune status of the birds and the virulence of the IBDV strain.

Winterfield and Hitchner (1964) described vent pecking as the first sign of IBD outbreak. Cho and Edgar (1972) made a similar observation. Contrary to these reports vent pecking was not observed in this study and in the field IBD outbreaks in Nigeria (Onunkwo, 1975, 1978; Okoye and Uzoukwu, 1981, 1982). It may be that the Nigerian strains of IBDV are not as irritating to the bursa as the foreign strains that cause vent pecking.

Cosgrove (1962) described trembling as one of the clinical signs of IBD. This observation was later confirmed by Parkhurst (1964), Edgar and Cho (1966), Landgraf et al. (1967), Cho and Edgar (1972) and Hirai et al. (1973). But no such sign was observed in this study and in the field IBD outbreaks in Nigeria (Onunkwo, 1975, 1978; Okoye and Uzoukwu, 1981, 1982). The mortality rate in this case is not comparatively low despite the fact that it was based only on the birds that died on their own. Many of the infected birds were sacrificed. But the fact that initial mortalities were higher is characteristic of IBD (Luthgen, 1969).

Cosgrove (1962) reported that there was no rise in body temperature at any stage of IBD. But similar to the findings of Cheville (1967), and Cho and Edgar (1972), temperature increase was observed in this case on days 1 and 2 PI. This could be due to viraemia.

The gross pathological lesions observed in this case are similar to those already described by other workers (Cosgrove, 1962; Helmboldt and Garner, 1964; Hanson, 1967; Del Bono et al., 1968; Cho and Edgar, 1972; Henry et al., 1980). But an attempt has been made in this study to describe the gross pathological changes of IBD in chronological order in most of the organs affected. This may be useful in assessing the time of infection in field IBD outbreaks.

References


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The Species of *Eimeria* in Chickens Examined at Nsukka Area of Anambra State, Nigeria

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**Summary**

Six species of coccidia were identified from the intestines of 450 birds examined at Nsukka. 150 intestines were from birds that died of various causes at the University of Nigeria Farm, while 300 intestines were from birds slaughtered at different hotels in the town. The *Eimeria* species identified were: *E. tenella*, *E. necatrix*, *E. acervulina*, *E. maxima*, *E. brunetti* and *E. mitis*.

The level of infection was seen to relate to management methods, medication and breed of birds.

**Introduction**

The domestic chicken is the most prolific of all farm animals, being capable of producing up to 200 eggs or offspring per year (Obioha, 1976). This qualifies poultry production as an area of great emphasis and prospects in Nigerian agriculture. The greatest deterrent to this is poultry diseases which usually appear as outbreaks killing off large numbers of birds. Coccidiosis, one of these diseases (Adene, 1976), occupies a high place of importance.

The Nigerian poultry industry at present is made up of both exotic and indigenous breeds and an attempt has been made in this study to determine the *Eimeria* species harboured by the different breeds and the possible influence of some aspects of management on the intensity/nature of the infection in birds examined in Nsukka area of Anambra State.

**Material and Methods**

Four hundred and fifty chicken intestines from Nsukka area of Anambra State were examined over a period of 14 months.

These consisted of 150 young pullets and broilers aged between 1 and 8 weeks that died from various causes, principally Gumboro and Mareks diseases, on the University of Nigeria Farm. The management of these birds was not the best as they were reared on deep litter under repeated use with no serious emphasis on prophylactic medication such as anti-coccidial medication.

The second group of birds used were 150 adult broilers slaughtered in a standard hotel. These birds were bought from a farm where they were well catered for. Although they were reared on deep litter, conventional poultry management practices such as good hygiene and medication were emphasized.

The third group of birds were 250 indigenous adult chickens slaughtered in different roadside eating houses. These birds were reared under the free range management system, as is the common practice in the villages where they are principally kept.

**Identification of Eimeria Species**

Species of *Eimeria* were established on the basis of regions of the intestines parasitized and their specific pathological lesions as described by Reid and Long (1979). Oocyst shape, colour, sporulation time and shape index (mean length/mean width) were some of the other parameters considered for speciation.

**Preparation of Materials for Oocyst Identification**

Faecal contents and intestinal scrapings from suspected specific regions of fresh intestines were separately homogenized, sieved and sedimented using a centrifuge at 1500 rev/min for 2 minutes. Aliquots from the sediments were mixed in about five times their volume of 2.5% potassium dichromate solution in petri dishes. Oocysts were allowed to sporulate at room temperature. The sporulation times were recorded and averages for the different species of *Eimeria* identified calculated.
Predominance Ratios: Calculation of Percentage Occurrence

\[
\% \text{ Occurrence of a species} = \frac{\text{Number of birds positive for that particular species}}{\text{Number of birds positive for one or more species}} \times 100
\]

\[
\% \text{ Predominance of species} = \frac{\text{Number of birds with the most severe pathological lesions of the particular species}}{\text{Number of birds positive for one or more species}} \times 100
\]

Results

The level of coccidial infection, the percentage of intestines infected, number of species of *Eimeria* identified with their incidence, percentage occurrence and predomiance ratios in the three groups of birds are shown in Tables 1 and 2.

Table 1: The Level of Coccidial Infection and the Frequency of Species in the Individual Intestines

<table>
<thead>
<tr>
<th>Location</th>
<th>Percentage of intestines containing No. of species of <em>Eimeria</em>/intestine</th>
<th>No. of species of <em>Eimeria</em> intestine</th>
</tr>
</thead>
<tbody>
<tr>
<td>University farm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>150 Intestines examined</td>
<td>28.70  6.00  32.70  21.30  9.30  2.00</td>
<td></td>
</tr>
<tr>
<td>Standard hotel</td>
<td></td>
<td></td>
</tr>
<tr>
<td>50 Intestines examined</td>
<td>72.00  4.00  2.00  4.00  ---</td>
<td></td>
</tr>
<tr>
<td>Roadside hotels</td>
<td></td>
<td></td>
</tr>
<tr>
<td>250 Intestines examined</td>
<td>47.60  14.40  19.20  15.20  3.20  0.40</td>
<td></td>
</tr>
</tbody>
</table>

It can be seen from Table 1 that infection was least in the broilers slaughtered in the standard hotel followed by the indigenous birds slaughtered in the roadside hotels. Also infection by one or more species of *Eimeria* was highest in the young pullets and broilers from the University of Nigeria Farm followed by the indigenous birds slaughtered in the roadside hotels.

It will also be seen (Table 2) that infections due to *E. tenella* and their predominance were highest in the young pullets and broilers collected from the University of Nigeria Farm while infection due to *E. necatrix* was higher in adult birds slaughtered in the standard and roadside hotels. They equally predominated in these groups. Although *E. maxima* and *E. mitis* were recorded, they did not predominate in any of the three groups of birds. *E. brunetti* although of fair occurrence in some of the birds only predominated in a few (8.40%) of the indigenous birds.

Table 2: The Incidence of Species and Their Percentage Occurrence: Predominance Ratios

<table>
<thead>
<tr>
<th></th>
<th>1 University Farm</th>
<th>2 Standard hotel</th>
<th>3 Roadside hotels</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>E. acervulina</em></td>
<td>58.92:13.10</td>
<td>78.60:57.10</td>
<td>75.60:54.20</td>
</tr>
<tr>
<td><em>E. necatrix</em></td>
<td>51.40:14.00</td>
<td>64.30:14.30</td>
<td>59.50:29.50</td>
</tr>
<tr>
<td><em>E. tenella</em></td>
<td>93.50:72.90</td>
<td>42.80:28.60</td>
<td>29.80:9.90</td>
</tr>
<tr>
<td><em>E. brunetti</em></td>
<td>40.20: ---</td>
<td>14.30: ---</td>
<td>43.50: 8.40</td>
</tr>
<tr>
<td><em>E. maxima</em></td>
<td>8.40: ---</td>
<td>---: ---</td>
<td>5.30: ---</td>
</tr>
<tr>
<td><em>E. mitis</em></td>
<td>4.10: ---</td>
<td>---: ---</td>
<td>2.30: ---</td>
</tr>
</tbody>
</table>

It was observed that the samples from the indigenous birds yielded fewer oocysts per each microscopic field examined when compared to their exotic mates. Also the pathological lesions were lightest in the indigenous birds.

In all the three groups of birds it was observed that of all the species of *Eimeria* identified, *E. brunetti* had the least yield of oocysts per field of the microscope.

Nature of Lesions

*Caecum.* The caecal lesions were due to *E. tenella* and were characterised by ballooning, accumulation of clotted blood and sometimes tissue debris. *E. brunetti* lesions extended to the proximal caecum in some of the birds.

They were observed to be most severe in the young pullets and broilers followed by the adult broilers. In most of the indigenous birds, infections were marked by mild petechia with slight ballooning.

*Rectum.* The rectal lesions were due to *E. brunetti.* They consisted of very fine petechia
usually in linear formations and were almost characteristic. Lesions were mildest in the indigenous birds.

Mid-gut. Mid-gut infections were found to be due to *E. necatrix*, *E. maxima* and *E. mitis*. They consisted of severe intestinal ballooning, thickening, haemorrhages and tenderness. The severity of the lesions was found to be greatest in pure infections of *E. necatrix*. Sometimes plaquelike spots were visible from the serosal surface. Lesions were mildest in the indigenous birds.

Duodenum. Duodenal lesions were due to *E. acervulina* and they consisted of mild to severe ballooning of the intestines and small whitish streaks which were visible from the serosa. Most of the severe cases showed mucosal surface petechial haemorrhages. Lesions were also mildest in the indigenous birds.

Table 3 gives the measurement in microns of the oocysts of *Eimeria* species identified at Nsukka.

<table>
<thead>
<tr>
<th>Species</th>
<th>Shape</th>
<th>Width</th>
<th>Length</th>
<th>Range</th>
<th>Sporulation time (hours)</th>
<th>Shape index</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>E. tenella</em></td>
<td>Oval (chicken-egg shape)</td>
<td>16.5 ± 2.85</td>
<td>22.75 ± 2.3</td>
<td>15 - 21 x 18 - 21</td>
<td>18 - 24</td>
<td>1.38</td>
</tr>
<tr>
<td><em>E. necatrix</em></td>
<td>Oval with little elongation</td>
<td>15.16 ± 1.05</td>
<td>19.42 ± 1.6</td>
<td>13.5 - 16.5 x 18 - 22.5</td>
<td>*18 - 24</td>
<td>1.28</td>
</tr>
<tr>
<td><em>E. acervulina</em></td>
<td>Fine oval tending towards circular</td>
<td>15.3 ± 0.4</td>
<td>17.1 ± 0.8</td>
<td>15 - 15.75 x 15.7 - 18</td>
<td>&lt; 24</td>
<td>1.1</td>
</tr>
<tr>
<td><em>E. maxima</em></td>
<td>Large oval with golden-brown tinge</td>
<td>27.13 ± 1.86</td>
<td>32 ± 2.24</td>
<td>24 - 30 x 30 - 36</td>
<td>24 - 36</td>
<td>1.18</td>
</tr>
<tr>
<td><em>E. brunetti</em></td>
<td>Oval</td>
<td>12.25 ± 0.35</td>
<td>16.5 ± 1.06</td>
<td>12 - 12.72 x 15 - 17.25</td>
<td>&lt; 24</td>
<td>1.35</td>
</tr>
<tr>
<td><em>E. mitis</em></td>
<td>Almost circular</td>
<td>15.9 ± 1.04</td>
<td>16.1 ± 1.3</td>
<td>14.25 - 17.25 x</td>
<td>14.25 - 18</td>
<td>1.01</td>
</tr>
</tbody>
</table>

*Within this period (18-24 hours) more oocysts of *E. necatrix* sporulated than those of *E. tenella.*

**Discussion**

*Eimeria tenella* infection accounted for 93.5% (highest score) of the positive cases, being most predominant (72.9%) in the young pullets and broilers collected from the University Farm (Table 2). The pronounced lesions observed are in line with the observations of Davies *et al.* (1963) in young pullets and broilers of about 1 - 8 weeks of age. Birds within this age were equally found to be more prone to attacks of *E. tenella* (Hofstand *et al.*, 1978; Herrick *et al.*, 1936; Gardiner, 1955). The last author went on to show that birds are more susceptible to *E. tenella* at about the fourth week of life, an age to which most of the birds in this group belong. This susceptibility may account for the high level of mixed infections recorded in this group (Table 1).

The presence of other intercurrent infections such as Gumboro and Mareks diseases in this group of birds appears to be responsible for the extra-severity of coccidiosis (high morbidity and mortality) observed. This agrees with the observation of Okoye (1983); Giambrone *et al.* (1976) and Anderson *et al.* (1977) who reported an increased severity in the pattern of outbreaks of coccidiosis in groups of birds suffering from other intercurrent diseases.

The fact that these birds were kept intensively on deep litter, some under repeated use, can further advance reasons for
the high incidence, morbidity and mortality recorded in this group. This thinking is in line with the findings of Biddle et al. (1963).

Other species of *Eimeria* isolated from this group include *E. acervulina* (58.9%) from the duodenum; *E. necatrix* (51.4%), *E. maxima* (8.4%), *E. mitis* (4.1%) all from the mid-gut. The specific characteristics of *E. maxima* as the largest chicken oocyst with a golden-brown wall (tinge) and *E. mitis* as the only chicken coccidium that is nearly circular in shape made their identification much easier. Although *E. mitis* is found principally in the upper one-third of the intestine (Reid and Long, 1979) some of the isolations in this study were made from the lower portions of the intestines which agrees with the observations of Davies et al. (1963).

*E. brunetti* (40.2%) was isolated from the rectum and at times, from the proximal part of the caecum. The apparent low yield of oocysts of *E. brunetti* in the positive cases could be associated with the peculiar anatomical structure (almost a straight tube) and location of the rectum which do not favour faecal accumulation.

The sub-clinical nature of infections generally observed in the indigenous birds and the lower percentage of multiple infections (Table 1) may be due to their comparatively resistant nature to diseases as suggested by Aire et al. (1974) and Ayeni (1976). It can also be due to the general practice of rearing these birds (free-range) in the villages where they are kept. This practice makes them pick sporulated oocysts early in life from their environment, as a result of which they acquire resistance to coccidiosis as described by Herrick et al. (1936), Gordeuk et al. (1951) and Johnson (1927).

The high incidence and predominance of *E. acervulina* infections, followed by those of *E. necatrix* and *E. brunetti* in this group (Table 2) is in line with the findings of Johnson (1930) who recorded high incidence of these species of *Eimeria* in growing and older birds as against *E. tenella* which was found to have higher incidence and more pathogenic effect in young birds.

The incidence of fewer positive cases (14 out of 50 birds) among the adult broilers in group 2 appeared to be due to the management practice in the farm from where they were collected. It was learnt that those birds were placed on coccidiostats virtually all their life, coupled with the high level of hygiene observed in the farm. The drinking containers were washed daily while the feed containers were washed weekly. The infections that were observed in some of the birds might be due to resistant strains of *Eimeria*. This situation has been reported from many farms and were ascribed to drug abuse (Fatunmbi, 1981). The lesions observed for the different species of *Eimeria* in this study conform to a great extent to the descriptions given by some other workers like Morehouse and McGuire (1958), Davies et al. (1963) and Siegmund et al. (1975).

The measurement values of oocyst obtained in this study (Table 3) compares favourably with those of other workers like Becker (1956), Tyzzer (1929, 1932), Edger (1955), Joyner (1958) and Davies (1956).

The only minor differences were in the values of the oocyst shape index, that is, mean length/mean width (Reid and Long, 1979), where their values as against those of these authors are *E. acervulina* 1.25:1.1; *E. tenella* 1.16:1.38; *E. necatrix* 1.19:1.28; *E. maxima* 1.47:1.18; *E. mitis* 1.01:1.01; *E. brunetti* 1.31:1.35.

The other point of difference is the measurement (length x breadth) values for *E. brunetti* that were on the lower side when compared with the values obtained by some of the workers mentioned above, but are within the range indicated by Becker et al. (1955).

It is not proper to conclude that the rest of the species of *Eimeria* of chicken not recorded in this study, are not present in Nsukka as in outbreaks of intestinal coccidiosis where a number of species are involved, it would be difficult to detect the presence of some species like *E. praecox* due to lack of characteristic lesions (Davies et al., 1963). For the specific identification of some of these species such as *E. praecox* and *E. hagani*, cross-immunity studies have to be embarked upon (Chute et al., 1960) which were not included in this preliminary study.

Acknowledgement

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The Incidence of Infectious Bovine Keratoconjunctivitis in Kenyan Cattle and the Effectiveness of Treatment with Penicillin and Chloramphenicol

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Kikuyu, Kenya

Summary

Clinical examination of 2,540 cattle in six herds in Kenya revealed a high incidence of infectious bovine keratoconjunctivitis. The disease with varying degrees of ocular involvement was observed in 328 (12.9%) of the animals examined. 184 (56.1%) of the affected animals showed bilateral eye involvement while only one eye was affected in the remaining 144 cattle.

Bacteriological and virological examination of ocular secretions collected from 25 eyes of cattle with the disease resulted in the isolation of Neisseria catarhalis from all the affected eyes. The effectiveness of penicillin and chloramphenicol ophthalmic ointments in the treatment of the disease was examined. No significant differences were observed in the recovery rates between the animals treated either with penicillin or chloramphenicol ointments. Recovery rates were higher in the animals treated daily for 7 days than in those animals subjected to three treatments given at 2-day intervals.

Introduction

Infectious bovine keratoconjunctivitis (IBK) is a widespread disease of great economic significance to cattle farmers throughout the world. In some countries IBK is the deciding factor between profit and loss to the dairy and beef industries (Thrift and Overfield, 1974; Thomas et al., 1978). It is a debilitating disease affecting cattle of all ages although young animals are most susceptible (Wagener and Mitscherlich, 1942; Slatter et al., 1982).

Moraxella bovis is considered to be the major causative agent of the disease but some studies have implicated Neisseria catarhalis (Smith, 1967; Wilcox, 1970; Fraser and Gilmour, 1979); Mycoplasma conjunctivitis (Trotter et al., 1977); and infectious bovine rhinotracheitis virus (IBRV) (St. George, 1965; Provost and Borredon, 1965) in the causation of IBK. In addition, several reports have shown dry conditions with associated factors like u.v. radiation, flies, dusty conditions, presence of long dry grass and husbandry practices to favour the spread of the disease (Baldwin, 1945).

Although IBK affected animals are known to recover spontaneously without treatment, some cases of the disease terminate in blindness, and loss of milk production and body weight are common findings in the affected animals (Frisch, 1975; Dodt, 1977; Slatter et al., 1982). During the dry seasons between December 1981 and February 1982, several cases of IBK were observed in different parts of Kenya. Following this observation, it was thought desirable in terms of epidemiology to determine the incidence of and the organisms involved in this disease. The effectiveness of penicillin and chloramphenicol, the most commonly used ophthalmic drugs in the treatment of the disease in Kenya was also assessed.

Materials and Methods

Clinical Examinations

A total of 2,540 cross-breed cattle of mixed ages were examined for clinical evidence of IBK during the dry seasons between December 1981 and February 1982. The animals were examined in six different farms located on the Veterinary Research Department (VRD) farm, Muguga; Mbaruku area, Nakuru; Matunda, Eldoret; Endebes, Cherenganyi Hills and Kiminini areas in Kitale. The herds were examined for total number of animals in the herd and the corresponding number of animals clinically affected by the disease. The number of cattle affected were recorded for unilateral and bilateral eye involvement.

Bacteriology

A total of 61 samples were collected from 35 animals in a herd of 150 cattle. Twenty-five
of the samples were taken from clinically affected eyes while 36 samples were from clinically normal eyes.

Ocular secretions were collected on sterile cotton wool swabs from beneath the lower eyelid. The swabs were immediately streaked on sheep blood agar plates and incubated at 37°C for 18 hours. Following the primary isolations, further cultural methods, media and biochemical tests were as described by Cowan and Steel (1974), Bovre and Henriksen (1976) and Fraser and Gilmour (1979). The elongation test was conducted according to the method of Fraser and Gilmour (1979). The catalase test, gelatin liquefaction and carbohydrate fermentation tests were as described by Frazier (1926) and Thompson and Knudsen (1958) respectively.

Virology

Ocular swabs for virus isolation were collected in phosphate buffered saline solution containing bovine albumin, penicillin and streptomycin. The secretions were clarified by centrifugation at 400 g for 10 minutes and inoculated onto confluent primary bovine kidney cell cultures prepared as previously described (Plowright and Ferris, 1959). The cultures were incubated at 37°C in roller drums and examined daily for 21 days for the development of cytopathic effects.

Animal Treatment

Sixty cattle manifesting mild to severe IBK infection on the VRD farm were divided into five groups of 12 animals per group. Each group was further subdivided into five classifications on the basis of the number of eyes affected and the severity of corneal lesions. With slight modification, the severity of corneal lesions in each eye was assessed and characterised as previously described (Pugh et al., 1979). This classification was as follows:

None - Clinically unaffected
Class I - Small ulcer, 1-2 mm in diameter
Class II - An ulcer 3-4 mm in diameter
Class III - Corneal change more severe than Class II but less severe than Class IV
Class IV - Change in which panophthalma and blindness existed concomitantly with Class III corneal changes.

Animals in groups 1 and 2 were treated with penicillin and those in groups 3 and 4 received chloramphenicol ophthalmic ointments.

Groups 1 and 3 animals were treated once daily for 7 days and animals in groups 2 and 4 received three treatments each applied at 2 day intervals. Animals in group 5 were left as untreated controls. The procedure of drug application to the animals was conducted as described by Jackson (1953). All the animals were housed throughout the experimental period and examined daily for 2 weeks following the last drug application.

Results

Of the 2,540 animals examined on the six farms, 328 showed varying degrees of IBK infection thereby giving a mean cattle incidence of 12.9% (Table 1). The commonly observed clinical signs were serous to mucopurulent ocular discharges, photophobia, keratitis, corneal opacity and ulcerations of varying sizes and severity. Severe signs of hypopyon, ruptured eyeballs and complete eye blindness were found in a total of 26 affected animals. Of the total 328 affected animals 184 (56.1%) had bilateral eye infection while unilateral ocular infection was observed in the remaining 144 cattle. The incidence of IBK was higher in farms around Kitale than those near Nakuru and Eldoret. The farm in Mbaruku had a cattle incidence of 5.9% while in Endebes a higher incidence of 19.4% was observed.

<table>
<thead>
<tr>
<th>Herd</th>
<th>No. of cattle examined</th>
<th>No. of cattle affected</th>
<th>Affected (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>VRD Muguga</td>
<td>800</td>
<td>94</td>
<td>11.8</td>
</tr>
<tr>
<td>Endebes, Kitale</td>
<td>346</td>
<td>67</td>
<td>19.4</td>
</tr>
<tr>
<td>Kiminini, Kitale</td>
<td>294</td>
<td>56</td>
<td>19.0</td>
</tr>
<tr>
<td>Cheranganyi, Kitale</td>
<td>320</td>
<td>51</td>
<td>16.0</td>
</tr>
<tr>
<td>Matunda, Eldoret</td>
<td>540</td>
<td>46</td>
<td>8.5</td>
</tr>
<tr>
<td>Mbaruku, Nakuru</td>
<td>240</td>
<td>14</td>
<td>5.9</td>
</tr>
<tr>
<td>Total</td>
<td>2,540</td>
<td>328</td>
<td>12.9</td>
</tr>
</tbody>
</table>

Bacteriology

No bacterial growth was observed in swabs from 34 normal eyes. Only two clinically unaffected eyes showed positive bacterial growth. Bacteria were, however, detected in
all the 25 affected eyes. The only bacterium encountered in all cases was Gram negative, oxidase positive cocccus, belonging to the genus Neisseria. The isolate was non-haemolytic on sheep blood agar, was aerobic, non-motile and failed to produce acid from glucose, maltose, lactose, arabinose and xylose. The bacterium did not peptonize litmus milk but reduced nitrates to nitrites. Growth occurred on MacConkey agar at 37°C but negative results were observed for gelatin liquefaction and urease tests. Pathogenicity tests in animals were not conducted. The cultural, morphological and biochemical characteristics confirmed the isolate to be N. catarrhalis.

Virology
No cytopathic agents were isolated from the ocular samples during the 21 days observation period.

Animal Treatment
Table 2 shows the number of cattle eyes affected by IBK before and after treatment with penicillin and chloramphenicol ophthalmic ointments and recovery rates at 2 weeks after the last drug application. Of the 18 affected eyes in animals in group 1, 12 (67%) had no clinical evidence of IBK 2 weeks after a daily course of treatment with penicillin for 7 days. Using a similar schedule of treatment with chloramphenicol for animals in group 3, a total of 10 (59%) out of 17 affected eyes recovered completely. Only 5 (33%) of the 15 affected eyes in group 2 animals recovered following penicillin treatments applied at 2 days interval. Chloramphenicol applications at 2 days interval resulted in 22% eye recovery as observed in animals in group 4. At the termination of the experiment no significant spontaneous recovery had occurred in the untreated control group 5 animals. In all the four treated groups, there was an overall good recovery response in eyes exhibiting class I and II corneal lesions. Few eyes with class III lesions responded to treatment in animals treated with penicillin for 7 days (group 1). No complete recovery was observed in eyes with class IV lesions.

Table 2: Cattle Eyes with Various Grades of Corneal Lesions Before and After Treatment

<table>
<thead>
<tr>
<th>Experimental group</th>
<th>Eyes affected</th>
<th>No. of eyes and severity of corneal lesions</th>
<th>Recovery after 2 weeks (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No.</td>
<td>%</td>
<td>None</td>
</tr>
<tr>
<td>Before treatment</td>
<td>18</td>
<td>75</td>
<td>1</td>
</tr>
<tr>
<td>1 2 Weeks after treatment</td>
<td>6</td>
<td>25</td>
<td>18</td>
</tr>
<tr>
<td>Before treatment</td>
<td>15</td>
<td>63</td>
<td>9</td>
</tr>
<tr>
<td>2 2 Weeks after treatment</td>
<td>10</td>
<td>42</td>
<td>14</td>
</tr>
<tr>
<td>Before treatment</td>
<td>17</td>
<td>71</td>
<td>7</td>
</tr>
<tr>
<td>3 2 Weeks after treatment</td>
<td>7</td>
<td>29</td>
<td>17</td>
</tr>
<tr>
<td>Before treatment</td>
<td>18</td>
<td>75</td>
<td>6</td>
</tr>
<tr>
<td>4 2 Weeks after treatment</td>
<td>14</td>
<td>58</td>
<td>10</td>
</tr>
<tr>
<td>Initially 3 Weeks later</td>
<td>16</td>
<td>67</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>15</td>
<td>63</td>
<td>9</td>
</tr>
</tbody>
</table>
Discussion

The widespread nature of IBK in Kenya is indicated by the various reports on its occurrence from most provinces of Kenya (Veterinary Department, 1968 to 1982). The high mean incidence of 12.9% observed in this study indicates that a large proportion of animals in this country suffer from this disease. IBK has been shown to be most prevalent at the time of the year when u.v. radiation and dry conditions are highest (Farley et al., 1950). The high incidence in the cross-breed cattle in this survey during the dry season may be a reflection on climatic conditions since the spread of the disease has been observed to cease and even die out in cooler weather with fewer flies (Faull and Hawksley, 1954). In addition, it is proposed here that the prevalence of the disease might be higher in Bos taurus breeds in this country than that observed in the present study. Many workers have reported different breed susceptibilities to IBK (Jackson, 1953; Griffin et al., 1965; Frisch, 1975; Slatter et al., 1982) with indigenous or cross-breeds showing lower susceptibility than Bos taurus breeds especially in tropical and subtropical regions. The incidence of the disease varied from one area to another being higher in Endebes area in Kitale (19.4%) and lower in Mbaruku near Nakuru (5.9%). This agrees with the observation that more than 20% of cattle in the same herd can be affected by IBK at the same time (Faull and Hawksley, 1954). In the absence of information on the prevalence and economic impact of IBK in Kenyan cattle, the high incidence of the disease observed in this study should be of concern.

Infectious bovine keratoconjunctivitis is considered to be caused mainly by Moraxella bovis (Gallagher, 1954). Neisseria catarrhalis has been frequently isolated either alone or in association with other organisms from cases of IBK (Spradbrow, 1967) and also from normal cattle eyes. Although it has generally been considered to have low pathogenicity, to our knowledge its aetiological role in IBK has never been tested. The isolation of this organism alone from 100% of cattle eyes with keratoconjunctivitis calls for more close investigations into its role in the disease. The association of infectious bovine rhinotrachitis virus with IBK was reported by St. George (1965), but in this study neither IBV nor M. bovis were isolated. Since it was considered that the methods employed in this work were adequate to demonstrate the presence of either organism, this study did not reveal the causative agent of this disease. Studies to determine the pathogenicity role of N. catarrhalis in cattle eyes will have to be conducted.

It has become evident that a wide range of antimicrobial drugs while not affecting a rapid regression of corneal lesions (Jackson, 1953) are effective in halting the progressive development of IBK symptoms (Formston, 1954; Cooper, 1960). Chloramphenicol and penicillin eye ointments are the most commonly used ophthalmic drugs in Kenya. Comparative treatment of affected cattle eyes in this study did not show great difference in recovery rates between animals treated with either drug when applied daily for 7 days. The observation by Faull and Hawksley (1954) that application of these drugs early in the course of the disease effectively halts the progressive corneal invasion was also shown in the present work. Although intermittent application of the drug did not result in high recovery rates, it reduced the progressive invasion. Only one eye recovered in the untreated control animals. Spontaneous resolution is known to occur in IBK, however, this is usually a lengthy process (Formston, 1954; Cooper, 1960).

Acknowledgement

We wish to record our thanks to B. Oduor, E. Maloba and Mr. Ambani for their technical assistance. This paper was published with the permission of the Director, Veterinary Research Department, Muguga.

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Kenya Veterinary Department (1968 to 1982). *Annual Reports*.
Pugh, G.W., McDonald, T.J. and Booth, G.D. (1979).


Received for publication on 2nd February 1984.
Caseous lymphadenitis (CLA), a chronic disease of sheep is widespread in many parts of the world (Beveridge, 1983). It is of economic importance particularly in countries deriving foreign exchange earnings from export trade. In recent years, CLA had been recognized as a major problem in the sheep and goat industry and the causative agent Corynebacterium pseudotuberculosis (C. ovis) had also been associated with a variety of other clinical conditions of farm livestock in Northern Nigeria (Addo et al., 1974; Addo and Eid, 1978; Addo, 1980a,b; Addo et al., 1980). We report here the infection in sheep in Ile-Ife, a town in the southern part of Nigeria.

Swellings of about 30-40 mm in diameter were observed around the neck and upper limbs in sheep at the experimental sheep and goat unit of the University of Ile. The goats were not affected. The lesions had ruptured in four sheep releasing viscous cheese-like purulent material with a slightly greenish tinge. Blood cultures at 37°C yielded pure brittle, ivory-coloured and beta-haemolytic colonies after 72 hours. These were identified as C. pseudotuberculosis after the methods of Cowan and Steel (1975).

Superficial lymph nodes are usually affected in CLA but visceral lesions may also be found. We recorded no deaths in this investigation although affected animals were in a debilitated condition. The corynebacterial infections previously reported in this locality were due to C. progenes (Falade, 1974; Ojo and Falade, 1974; Falade et al., 1977; Falade and Durojaiye, 1978; Oladosu et al., 1978; Falade et al., 1983). However, this is the first report of the occurrence of C. pseudotuberculosis in Ile-Ife.

References

Received for publication on 28th February 1984.
Case Report

OF MEDICAL OBSERVATION

Department of Medicine, University of California, Los Angeles

Introduction to diagnosis and treatment of acute diseases of the heart.

Diagnosis and therapy of acute myocardial infarction.

The importance of early recognition and prompt treatment.

Conclusion: The need for continued research in myocardial infarction.
A Serological Survey of Canine Distemper in Nigerian Dogs

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National Veterinary Services Laboratories, US Dept. of Agriculture, Animal Health Inspection Services, P.O. Box 844, Ames, Iowa 50010 USA

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M.A. MUHSIN
Dept. of Veterinary Microbiology and Preventive Medicine, College of Veterinary Medicine, Iowa State University, Ames, Iowa 50011 USA

Summary

A serum-neutralization (SN) test for canine distemper virus (CDV) antibody in cell culture in microtitration plates was carried out on 232 serum samples taken from apparently healthy dogs with no history of previous vaccination against canine distemper (CD). It was found that 47% of these dogs possessed antibody against CDV. In the owned dogs of known age, the groups with the largest percent positive were the oldest group (> 36 months) with 100% positive and the youngest group (≤ 6 months) with 90% positive. Within the stray dogs, 35% had antibody.

Introduction

Canine distemper (CD) is a world-wide disease of dogs. It is a highly contagious viral disease manifested by a biphasic fever, acute coryza followed by bronchitis and catarrhal pneumonia, severe gastroenteritis, and varying degrees of nervous symptoms (Bruner and Gillepsie, 1973).

The disease is important in Nigeria where it causes the death of many young dogs (Abdullahi, 1979). Besides the growing concern among small animal practitioners, dog owners (mainly exotic breeds), and security organizations about CD as a disease of dogs, there has been a concern about CD as a disease of humans (Burridge, 1981). In an effort to establish the status of CD among Nigerian dogs, a serological screening of 232 dogs from various parts of Nigeria was conducted.

Materials and Methods

Sera from apparently healthy dogs were collected from four northern states and five southern states of Nigeria. With 102 dogs, a history was obtained which indicated there was no previous vaccination for CD. With 130 dogs, a vaccination history could not be obtained. Imported dogs or dogs of exotic breeds were excluded from the study since antibody titres in these dogs would probably be due to vaccination rather than exposure to CD virus.

A microneutralization test (Appel and Robson, 1973) conducted with Vero cells and the Ondersteapoort CD virus strain was used to detect antibody. The sera were screened for antibody at a single dilution of 1:8 and the results determined after 3 days incubation at 37°C.

Results

Of the 232 samples examined, 108 (47%) were positive for CD antibody. The distribution by age and sex of the positive samples from the 102 dogs for which that information was known is presented in Table 1. Seventy-four % of these dogs had CD antibody. Table 2 divides the remaining 130
Table 1: Canine Distemper Antibody in 102 Owned Dogs of which Age and Sex Were Known

<table>
<thead>
<tr>
<th></th>
<th>Age (months)</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>≤6</td>
<td>7-12</td>
<td>13-18</td>
<td>19-24</td>
<td>25-30</td>
<td>31-36</td>
<td>&gt;36</td>
</tr>
<tr>
<td>Male</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pos.*</td>
<td>22</td>
<td>13</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Neg.</td>
<td>3</td>
<td>10</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Pos. (%)</td>
<td>88</td>
<td>57</td>
<td>60</td>
<td>0</td>
<td>0</td>
<td>50</td>
<td>100</td>
</tr>
<tr>
<td>Female</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pos.</td>
<td>13</td>
<td>9</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>11</td>
</tr>
<tr>
<td>Neg.</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>5</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Pos. (%)</td>
<td>93</td>
<td>75</td>
<td>67</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>Total</td>
<td>35</td>
<td>22</td>
<td>5</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>12</td>
</tr>
<tr>
<td>Pos. (%)</td>
<td>90</td>
<td>63</td>
<td>63</td>
<td>0</td>
<td>0</td>
<td>33</td>
<td>100</td>
</tr>
</tbody>
</table>

*Pos. = antibody titer of ≤ 1:8

Table 2: Canine Distemper Antibody in 130 Dogs of which Age and/or Sex Were Unknown

<table>
<thead>
<tr>
<th></th>
<th>Owned dogs</th>
<th>Stray dogs</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pos.*</td>
<td>7</td>
<td>26</td>
<td>33</td>
</tr>
<tr>
<td>Neg.</td>
<td>49</td>
<td>48</td>
<td>97</td>
</tr>
<tr>
<td>Pos. (%)</td>
<td>13</td>
<td>35</td>
<td>25</td>
</tr>
</tbody>
</table>

*Pos = antibody titre of ≥1:8.

Dogs by ownership. Only 13% (7 of 56) of the owned dogs without age and sex information and 35% (26 of 74) of the stray dogs were positive.

**Discussion**

From this study it is evident that CD is an important disease in Nigeria with 47% of the dogs possessing antibody. In the dogs of known age, the groups with the largest positive percentage were the oldest group (>36 months) with 100% positive and the youngest group (≤6 months) with 90% positive. The youngest dog was 3 months of age and it is generally believed that maternal antibody declines to a level that will not interfere with vaccination by this time. But, since only 63% of the dogs in the next oldest age group (7-12 months) were positive, it must be assumed that some maternally derived antibody was being measured in the younger dogs. In the three youngest age groups, the percentage of positive male dogs was higher than the percentage of positive female dogs. However, this observation was not statistically significant.

The reason for the higher percentage of positive dogs among the owned dogs of known age and sex (74% positive) as compared to the owned dogs without age and sex information (13% positive) and the stray dogs (35% positive) is not clear. However, since vaccination is not a factor in Nigeria, it can be assumed that, except for the very young dogs, the presence of antibody to CD is a result of recovery from the disease. The lower positive rate in the stray dogs could then be explained by a higher mortality rate in that group due to a lack of husbandry when these dogs become ill. Without care, fewer stray dogs would recover from CD, and this would result in fewer sero-positive dogs in the population. The care given to owned dogs when ill would result in a higher recovery rate and thus a high percentage of seropositive dogs.

**References**


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Geographical Distribution of CONTAGIOUS BOVINE PLEUROPNEUMONIA in Africa

OAU/STRC INTERAFRICAN BUREAU FOR ANIMAL RESOURCES

MAP NO. 517
1984

- Foci reported
- Widespread
- Enzootic/sporadic but no foci reported
- No official information available

Geographical Distribution of CONTAGIOUS CAPRINE PLEUROPNEUMONIA in Africa

OAU/STRC INTERAFRICAN BUREAU FOR ANIMAL RESOURCES

MAP NO. 518

1984

- Foci reported
- Widespread
- Enzootic/sporadic but no foci reported
- No official information available

Geographical Distribution of ANTHRAX in Africa

OAU/STCR
INTERAFRICAN BUREAU FOR
ANIMAL RESOURCES

MAP NO. 519

1984

■ Foci reported

X Widespread

☐ Enzootic/sporadic but no foci reported

♦ No official information available

Geographical Distribution of BOVINE BRUCELLOSIS in Africa

OAU/STRC
INTERAFRICAN BUREAU FOR
ANIMAL RESOURCES

MAP NO. 520
1984

■ Foci reported
X Widespread
☑ Enzootic/sporadic but no foci reported
☐ No official information available

Geographical Distribution of BLACKQUARTER in Africa

OAU/STRC
INTERAFRICAN BUREAU FOR
ANIMAL RESOURCES

MAP NO. 521
1984

■ Foci reported
× Widespread
☐ Enzootic/sporadic but no foci reported
☐ No official information available

Geographical Distribution of BOVINE TUBERCULOSIS in Africa

OAU/STRC
INTERAFRICAN BUREAU FOR ANIMAL RESOURCES

MAP NO. 522
1984

■ Foci reported
× Widespread
□ Enzootic/sporadic but no foci reported
○ No official information available

ABSTRACTS

Vol. 33 No. 3 No. 62 - 89

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IBAR/1985 M.J. Corbel and E.L. Thomas

Use of Phage for the Identification of Brucella canis and Brucella ovis Cultures


AUTHORS' SUMMARY: The brucella phage strains R, R/O and R/C standardised at routine test dilution on their propagating strains were effective in identifying cultures of Brucella ovis and B. canis and in differentiating these from other non-smooth brucella isolates.

63
IBAR/1985 Y. Thiongane, Y. Leforban and M.P. Doutre

Botulism Type D in Senegal. A New Outbreak of Hydrous Origin Responsible for a High Mortality


AUTHORS' SUMMARY: A new outbreak of botulism type D, caused by the absorption of water contaminated by the corpse of an unknown small mammal is reported from the Linguere area. About 100 sheep, 50 goats, 5 horses and 10 cattle died. The strain isolated was isolated from the liver of a sheep and a horse. Its toxicity for mice is 10^5 ml. The number of cases already described in Senegal shows that botulism is an element of the tropical bacteriopathology which must be taken into account.

64
IBAR/1985 Dragan Savov

Strains of Salmonella and Escherichia coli in Man and Some Animal Species in Angola


AUTHOR'S SUMMARY: During four years from 1979 to 1983, 40 strains of Salmonella and 79 strains of E. coli were isolated from man, domestic animals and poultry, from bone and fish meals.

The strains of Salmonella belonged to 15 serotypes. Salmonella typhimurium had wider dispersion than the other types.

The analysis of 79 strains of E. coli indicated the frequency of the following serotypes: 01, 02, 04, 018, 026, 078, 0139, 0141 and 0149.

The data show that the strains of Salmonella and E. coli in Angola are not different from those of Europe and of other continents.

65

Natural Subclinical Salmonella Infection in Chickens: A Potential Model for Testing the Effects of Various Procedures on Salmonella Shedding


AUTHORS' SUMMARY: The influence of growth additives on the duration of Salmonella shedding has been variously reported. The different conclusions reached were mainly because of the different experimental systems used. In this paper a naturally infected chicken model for evaluating this problem is described. It simulated commercial conditions and proved to be reproducible in 13 groups, each of 125 birds, over a two-year period.

66
IBAR/1985 J.C. Anderson

Absence of Encapsulation in Strains of Staphylococcus aureus Isolated from Bovine Mastitis


AUTHOR'S SUMMARY: Thirty of 104 strains of Staphylococcus aureus isolated from clinical cases of bovine mastitis in England grew as diffuse colonies in serum soft agar (SSA). 45 grew as mixed diffuse and compact colonies and 29 yielded compact colonies only. The compact strains grew as diffuse colonies in SSA after one passage in the mammary gland of mice. However, none of the strains had an unstained halo when examined by the India ink technique and there was a 99.99% reduction in the viable numbers of the bacteria in 30 representative strains 24 hours after inoculation into the peritoneal cavity of mice. By contrast the truly encapsulated strain M had an unstained halo by the India ink technique and resisted phagocytic killing in the peritoneal cavity. It is concluded that these strains from cases of mastitis are not encapsulated and that growth as diffuse colonies in SSA is not a reliable test of encapsulation.

67
IBAR/1985 B. Sharma, S.K. Bandyopadhyay, R.C. Joshi and R.P. Bansal

Antibody Response of Cattle to Rinderpest Vaccine


AUTHORS' SUMMARY: Antibody production was studied in cattle infected with rinderpest vaccine virus. Vaccinated cattle produced both IgM and IgG serum antibodies. The IgG antibodies were mainly those of IgG2 subclass. No IgA antibody response was detected in vaccinated animals.

68
IBAR/1985 D.F. Adene and K. Howes

Occurrence of Leukosis-sarcoma Virus Related Neoplasms and Antibody in Nigerian Local Chickens

AUTHORS’ SUMMARY: The local (indigenous) chicken commands a considerable degree of importance in the agricultural and rural economy in Nigeria, and this has generated interest in many aspects such as nutritional studies, reproduction and disease problems. In the present study, 12.1% of all local chickens examined had neoplastic growths including osteopetrosis and connective tissue sarcomas which are leukemia related. In a separate investigation, subgroup “A” neutralising antibody to leukosis-sarcoma virus was detected in five samples including one from a Nigerian local chicken. There has been no published information on any aspect of leukosis-sarcoma group of avian neoplasms in the Nigerian local chicken.

69 IBAR/1985 A.A. Bassiouni, F.E. Saad, M.S. Saber, Y.I. Youssef and M.A. Bastami
Effect of Gumboro Disease Virus Infection on the Response of Chickens to Newcastle Disease Vaccination


AUTHORS’ SUMMARY: The effect of Gumboro disease virus infection at different ages on the response of chickens to Newcastle disease vaccine (F and Komarov strain vaccines) was studied. Chickens infected with Gumboro disease virus had lower haemagglutination inhibiting antibody titres and low protection percentage against challenge with velogenic viscerotropic Newcastle disease virus strain as compared with uninfected vaccinated controls. The immunosuppressive effect was more marked when infection took place on the 1st and 7th day of life than on the 14th and 21st day.

70 IBAR/1985 S.K. Sharma and D.K. Murty
Foot-and-Mouth Disease in Sheep. I. Antibody Response Following Experimental Infection


AUTHORS’ SUMMARY: Antibody responses of sheep following experimental infection with foot-and-mouth disease virus have been described. The virus neutralizing antibody became detectable by 4th to 6th day of exposure. Peak responses occurred between 12 and 18 days followed by a gradual decline in titre reaching the plateau by 5th day of exposure. The complement fixing and precipitating antibodies appeared on 10th day and persisted till 105th and 77th day of exposure respectively. With the indirect immunofluorescent antibody test, it was possible to detect antibody to virus infection associated antigen as early as 6th day after infection.

71 IBAR/1984 S. Prosperi, A. Irsara, G. Battelli and V. Sanguinetti
Vaccination of Cattle with Live and Inactivated Rabies Vaccines: A Study of Antibody Response


AUTHORS’ SUMMARY: The authors vaccinated 152 cattle divided into three groups against rabies. The first group received the ERA strain and the second group an inactivated vaccine. The third group received the inactivated vaccine on two occasions with an interval of 60 days between the two doses. Their antibody response was surveyed with the fluorescent foci-inhibition test carried out on blood samples collected during a 10-month period. All animals developed an almost identical antibody response. However, at the 6th and 10th months, there was a higher number of seropositive animals in the groups vaccinated with the killed vaccine.

72 IBAR/1984 K. Pfister, Ch. Daveau and P. Ambroise-Thomas
Partial Purification of Somatic and Excretory-Secretory Products of Adult *Fasciola hepatica* and Their Application for the Serodiagnosis of Experimental and Natural Fascioliasis Using an ELISA


AUTHORS’ SUMMARY: Six partially purified antigen fractions from adult *Fasciola hepatica* (three somatic tissues [Fhs] and three excretory products [Fhms]), were used in a micro-ELISA to monitor the serum antibody levels of an experimental rabbit *F. hepatica* infection. Fhs 1 detected infection after 19-26 days and the titre remained significantly higher than that of the controls until day 103 of infection (end of experiment). Using Fhm 1 and Fhm 2, antibodies were detected between 12 and 19 days after infection. Fhm 2 distinguished infected from uninfected rabbits during the entire experimental period, whereas Fhm 1 did not. Excretory-secretory products of a low molecular weight were also antigenic and could differentiate between infected animals and controls. One hundred and nine sera from naturally infected cattle and uninfected controls were tested with the same antigens. Although antibody was detected, the results were inconsistent and further purification of the antigens may eventually improve the sensitivity of the method.

73 IBAR/1985 S.N. Chiejina and C.O. Emehelu
Seasonal Changes in Pasture Populations of Infective Larvae of Gastrointestinal Nematodes of Cattle in Eastern Nigeria


AUTHORS’ SUMMARY: The seasonal changes in the populations of trichostregyld infective larvae (L3) on herbage and soil samples collected from pastures grazed by beef cattle were studied atNsukka, eastern Nigeria,
from April 1980 to July 1981. Large numbers of L3 were recovered from all samples collected during the rainy season (April to October). The rainy season herbage infestation was characterised by three clearly defined peaks. The first, which followed an 'early rains' (April) rise, occurred in the second half of May while the larger second and third peaks occurred in late July and October respectively. It is suggested that each of these peaks represented a distinct wave of infestation by a separate generation consisting of the three trichostrongyloid species Trichostrongylus axei, Cooperia, Haemonchus and Trichostrongylus species. Although there was a sharp fall in pasture infestation following the onset of the dry season, appreciable numbers of L3 were still present on herbage in early December. The implications of these findings have been discussed in relation to the choice of effective strategic anthelmintic programmes for the prophylaxis and control of bovine parasitic gastroenteritis in the Nsukka area.

76
IBAR/1984  J. Cabaret

Seasonal Changes in the Abomasal Nematodes of Naturally Infected Ewes in Moulay-Bouazza (Morocco)


AUTHORS' SUMMARY: The nematode populations of 93 abomasum of ewes from Middle-Atlas (Morocco) were studied over a period of 3 years. The main species present were Ostertagia circumcincta, Marshallagia marshalli, Trichostrongylus axei and T. vitrinus; less frequent species were O. ostertagi and O. trifurcata. Two peaks of infection were recorded, one at the end of winter or the beginning of spring (February-March), and another in autumn (September). The first population peak consisted mostly of O. circumcincta and T. axei and the second population peak, in autumn, had a high prevalence of M. marshalli and T. vitrinus.

77
IBAR/1985  F.O.I. Arene

Prevalence of Hydatid Cysts in Domestic Livestock in the Niger Delta


AUTHORS' SUMMARY: The prevalence of infection with hydatid cysts in pigs, cattle, sheep and goats in the Niger Delta area of Nigeria studied over a 10-month period was generally high; 56% in pigs, 42% in goats, 32% in cattle and 24% in sheep. This high prevalence rate is probably related to the socio-economic factors prevalent in the area. The high prevalence and variability of the cysts in pigs and cattle suggests that the strain of Echinococcus present in this area differs from those reported elsewhere.

78
IBAR/1984  Mark A. James

An Update of the Isolation and Characterization of Cultured-Derived Soluble Antigens of Babesia bovis

AUTHOR'S SUMMARY: In this paper recent progress concerning the identification of soluble antigens from cultures of *Babesia bovis* parasites is reviewed. Soluble antigens present in the supernatant of *B. bovis* cultures have been shown to be efficient immunogens for induction of protective immunity against bovine babesiosis. Immunohemal analysis of culture supernatants has demonstrated that at least three parasite antigens are released *in vitro*. Sodium dodecyl sulfate-polyacrylamide gel electrophoresis showed that at least two of these antigens have molecular weights within the range of 37,000 - 40,000 daltons. Crossed immunoelectrophoretic studies have further revealed an antigenic spectrum consisting of one major and two minor antigens with mobilities in the albumin and alpha1 regions. Within the infected erythrocyte, two antigens have been localized on or near the erythrocytic membrane, while the third antigen appears to be directly associated with the parasite.

79
**IBAR/1985**  P. Pozy

**Dairy Production in Burundi. I. Analysis of Dairy Performances of Ankole x Sahiwal Crossed Cattle in a Lowland Area (Ruzizi Plain)**


**AUTHOR'S SUMMARY:** Calving, lactation and dry period intervals have been calculated on 165 observations and were found to be 430, 248 and 182 days respectively.

On 184 lactations, the average handmilked quantity is 809 litres with a variation coefficient of 39%. By analysing the variance for the year, calving season and lactation order, it is found out that our type of Sahiwal seems to be in the ecological equilibrium with the environment in which it is managed and that a selection on the milk production basis has a tendency to increase performances significantly.

After 10 years observations, it has been possible to define the milk production characteristics of a herd of Ankole x Sahiwal crosses exploited under semi-arid conditions in the Ruzizi Valley. The average age at first calving is 1150 days with a variation coefficient of 14% on 72 observations.

80
**IBAR/1985**  P. Pozy and L. Munyakazi

**Dairy Production in Burundi. II. Analysis of Dairy Performances of Ankole Cattle in the Highlands**


**AUTHORS' SUMMARY:** In the study on milk production in a herd of Ankole cattle managed on semi-extensive system in the high altitude regions of Burundi, the authors have analysed the milk production characteristics of the Ankole cattle as well as the influence of certain ecological factors. It follows that:

- the average calving interval is 539 days (cv = 24.32%),
- the average lactation period is 198 days (cv = 33.36%),
- the average milk production is 605 kg (cv = 38.46%) of which 86.5 l (cv = 138%) are obtained from handmilking.

There is neither seasonal nor annual birth influence on age at first calving; the significant variations of the milk production are made obvious for the calving season and age of the calf at weaning.

81
**IBAR/1984**  D.P. Hennessy and P.E. Williamson

**Stress and Summer Infertility in Pigs**


**AUTHORS' SUMMARY:** A serious year-round fertility problem on a commercial pig farm was investigated. The problem was characterised by a high proportion of non-pregnant sows and giltts which showed a delayed return or failure to return to oestrus after a normal mating to a fertile boar. Several factors were identified that we considered to be placing undue stress on the breeding stock from weaning through mating and early pregnancy. When steps were taken to reduce the influence of these stressors there was a marked improvement in the herd farrowing rate. Across all months this improvement was largely due to a reduction in the number of sows showing delayed return or failure to return to oestrus after mating. There were no concomitant changes in other indices of performance. In conclusion this study has shown that stressful factors other than summer heat stress can cause a syndrome of delayed or failure to return to oestrus, this syndrome is common and perhaps wrongly called 'summer or seasonal infertility'. When given the appropriate combination and/or intensity of stressful stimuli, it can be manifest at any time of the year.

82
**IBAR/1985**  Um El Alim A. Idris, S.E.I. Adam & G. Tartour

**The Anthelmintic Efficacy of d.I. Tetramisole (**) Against *Haemonchus contortus* Infection in Goats**


**AUTHORS' SUMMARY:** Eleven nubian goats were divided in six groups for testing the efficiency of Tetramisole against *Haemonchus contortus*. The criteria were the ability to eliminate both parasites and eggs and the analysis of the histological comparison of changes in different organs and tissues ex-ante and ex-post treatment.

The anthelmintic efficiency is evident and worms disappear after a single oral dose of 40, 80 and 240 mg/kg live weight. Faecal egg counts indicate suppression of parasites, but retreatment is recommended after 3 weeks even at 80 mg/kg dosing to avoid reinfection from immatures more resistant than adults to the drug. Beyond this figure, Tetramisole is toxic to goats, and at 240 mg/kg, severe renal and hepatic insufficiencies occur with death as consequence.
Bioassay of Parvaquone in the Serum of Cattle Infected with *Theileria parva* and Treated with Clexon


AUTHORS’ SUMMARY: The concentration of parvaquone in the serum of cattle treated with Clexon was assayed by an *in vitro* method using cultured bovine lymphoblastoid cells infected with *Theileria parva* (Muguga). Drug concentrations were maximal in serum 3 hours after intramuscular administration of Clexon at 20 or 10 mg/kg bodyweight. Concentrations fell progressively to undetectable levels in about 96 hours following a dose of 20 mg/kg, 48 hours after 10 mg/kg. Concentrations resultant from a second dose of 10 mg/kg were similar to those of the first. Although there was not clear correlation between serum concentration of parvaquone and efficacy of treatment with Clexon in cattle infected with *T. parva*, these results were instrumental in the selection of a dosage regimen of two injections of Clexon, each of 10 mg/kg parvaquone, with an interval of 48 hours between doses.

Preliminary Pharmacokinetic Study of Isometamidium Chloride in Camels


AUTHORS’ SUMMARY: Isometamidium chloride was given to camels at a single intravenous dose rate of 0.5 or 1 mg kg⁻¹ and the plasma drug concentration measured spectrophotometrically at frequent intervals for up to 48 hours. Isometamidium chloride concentrations were found to be 9.8 ± 0.2 and 8.7 ± 0.2 µg ml⁻¹ half an hour after treatment with 1 and 0.5 mg kg⁻¹, respectively, and 1.7 ± 0.3 and 0.7 ± 0.3 µg ml⁻¹ after 24 hours. No measurable drug concentration was found 48 hours after dosing.

Experimental Combined Aflatoxin B₁ and Ochratoxin A Intoxication in Pigs


AUTHORS’ SUMMARY: Twenty-one pigs weighing approximately 18 kg were placed in seven groups of three and given diets containing respectively aflatoxin B₁ alone at 0.375 and 0.0705 mg/kg, ochratoxin A alone at 1 and 2 mg/kg aflatoxin B₁ plus 1 mg/kg of ochratoxin and 0.750 mg/kg aflatoxin B₁ and 2 mg/kg ochratoxin A. The remaining group served as untreated control. At the respective dose levels, pigs receiving similar doses of ochratoxin A alone or in combination with aflatoxin B₁ were similarly affected, the clinical effects of aflatoxin having been mostly obscured by those due to ochratoxin A. Mild degenerative hepatic changes typical of aflatoxicosis were observed in pigs fed this toxin alone or in combination with ochratoxin A. In kidneys of pigs fed diet containing 1 and 2 mg of ochratoxin A alone changes included interstitial fibrosis of the cortex and dystrophy and degeneration of the tubular epithelium. Similar lesions but less pronounced fibrosis were found in kidneys of pigs receiving both toxins. The respective lower dose levels of mycotoxins selected were judged to be about the no-effect levels for each dosed separately under the conditions of the trial. Such levels have been found not infrequently on mould infected grain and stock foods. The results highlight the difficulties that may be experienced in the recognition of such multymycotoxines as they are likely to occur in the field and indicate the need for toxicological analysis as well as pathological investigation in establishing a diagnosis.

Clinical and Experimental Modifications of Plasma Iron and Zinc Concentrations in Cattle


AUTHORS’ SUMMARY: Plasma iron and zinc concentrations were studied in pyrexic cattle or in cattle experimentally infected with infectious bovine rhinotracheitis virus or *Escherichia coli* endotoxin. Plasma iron and zinc levels tended to decline in the animals given endotoxin and in the pyrexic cattle, but the plasma iron level was only modified after experimental infectious bovine rhinotracheitis infection. These changes were not always related to pyrexia. Plasma iron and zinc concentrations taken together may be used as an indicator of infection.

Results of a Control Campaign Against River Tsetse Flies in Burkina Faso Using Deltamethrine Impregnated Screens


AUTHORS’ SUMMARY: During the dry season in 1983, a control programme against *Glossina tachinoides* and *Glossina palpalis gambiensis* was effected in Burkina Faso with the help of screens impregnated with deltamethrin. The results obtained over a length of 580 km of rivers that drain an area of 3,000 km² of pasture ground are very promising. The apparent densities of *Glossina* have been reduced by 92.54% for *Glossina tachinoides* and by 88.11% for *Glossina palpalis gambiensis*, which made possible the successful use of the sterile insect technique during the following rainy season. The association of these two methods permitted the
achievement of the eradication of riverine Glossina in the whole area.

The authors discuss the advantages and inconveniences of this new method under local conditions concerning climate and ecological peculiarities.

88
IBAR/1985  A.M. Bakeer, M.B. Samy and H. Soufy

Comparative Studies Between Avian and Human Tuberculosis in Guinea-pigs from the Histopathological Aspects


AUTHORS’ SUMMARY: Intramuscular inoculation of Mycobacterium tuberculosis (human strain) and Mycobacterium avian in guinea-pigs separately revealed microscopical granulomatous inflammation in lung, liver and spleen in addition to nephritis, nephrosis, pericarditis and myocarditis. The antibody formation began early at the 3rd week in human strain and later in the 4th week in avian strain.

89
IBAR/1985  Yuichi Yokomizo, Hiroyuki Yugi and Richard S. Merkal

A Method for Avoiding False-Positive Reactions in an Enzyme-Linked Immunosorbent Assay (ELISA) for the Diagnosis of Bovine Paratuberculosis


AUTHORS’ SUMMARY: An enzyme-linked immunosorbent assay (ELISA) was developed to detect specific antibodies against Mycobacterium paratuberculosis in bovine serum. Experiments were designed to find methods to avoid the false-positive reactions that frequently are encountered in ELISA for the detection of antibodies to protoplasmic antigen of Mycobacterium paratuberculosis. Sera examined were obtained from cattle infected with Mycobacterium paratuberculosis, Mycobacterium bovis, Mycobacterium kansasi, or Nocardia asteroides, from cattle which were negative in bacteriological examination but positive in the complement-fixation test for paratuberculosis, and from sheep infected with Corynebacterium pseudotuberculosis. Preabsorption of tested sera with Mycobacterium phlei resulted in substantially eliminating false-positive reactions. This absorption treatment had no effect on the ELISA antibody level of sera from cattle infected with Mycobacterium paratuberculosis. These results indicate that the false-positive reactions that occur in the ELISA test for the diagnosis of bovine paratuberculosis can be controlled by preabsorption of the tested serum with Mycobacterium phlei.
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