CLINICAL AND HAEMATOLOGICAL RESPONSES OF DOMESTIC DOGS AND FREE-LIVING JACKALS *(CANIS MESOMELAS)* TO *EHRLICHIA CANIS* INFECTION

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"THIS THESIS IS MY ORIGINAL WORK AND HAS NOT BEEN

PRESENTED FOR A DEGREE IN ANY OTHER UNIVERSITY."

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SUMMARY

CLINICAL AND HAEMATOLOGICAL RESPONSES OF DOMESTIC DOGS AND FREE-LIVING JACKALS *(CANIS MESOMELAS)* TO *EHRLICHIA CANIS* INFECTION

A high incidence of clinical and subclinical canine ehrlichiosis was found in dogs from Nairobi and the surrounding area, using a modification of an established blood mononuclear cell culture test. Clinical signs observed included pyrexia, depression, selective appetite, weight loss, splenomegaly, lymphadenopathy, epistaxis, haematemesis, haematuria, blood in faeces and haemorrhages in the skin and mucous membranes. Bleeding into joints and the spinal column, reduced conception rates and abortions also appeared to be associated with the presence of *Ehrlichia canis*. The frequency of these signs and corresponding changes in the blood were studied in 373 domestic dogs and 16 silver-backed jackals. The cases were grouped according to the major presenting signs and individual clinical cases representing the characteristics of most groups have been described. There was no difference in the clinical disease seen in pure-bred dogs*, German Shepherd dogs or cross-bred dogs.

Eight cross-bred puppies were experimentally infected with *E. canis* and the disease reactions were studied. The clinical and haematological changes were mild and transient in all but one of these dogs. These changes, though mild, were similar to

*(excluding German Shepherd dogs)

those presented by naturally occurring cases seen at the clinic. One of these eight dogs however, died after becoming severely pancytopenic. On post-mortem examination, extensive haemorrhages were found throughout the carcase and histologically plasma cell infiltration was evident in most organs. These findings were typical of the disease as described elsewhere in the world.

Tetracycline hydrochloride, doxycycline and imidocarb dipropionate were evaluated for their efficacy in the treatment of the clinical disease and for their ability in the elimination of the causative organism from the peripheral blood. All three drugs were effective in treating the clinical disease, but imidocarb dipropionate was the most efficient in eliminating the organism from the peripheral blood. The use of imidocarb dipropionate was associated with a number of undesirable side effects which have been documented. The responses of 153 of these clinical cases to treatment with these compounds were followed in detail.

Free-living jackals were shown to harbour *E. canis* using the blood mononuclear test. *Ehrlichia canis* from jackals was cultured and subinoculated into young cross-bred puppies. Clinical and haematological changes in these puppies indicated a disease process that was similar to that seen in the experimentally infected puppies and in many of the naturally occurring cases. *Rhipicephalus sanguineus* and *Haemaphysalis leachii*, which are common ticks on domestic dogs, were among

the tick species carried by these infected jackals and *R. sanguineus* is the known vector of ehrlichiosis. Tick-sharing could occur where dogs and jackals intermingle and it is likely that free-living jackals could act as a natural reservoir for ehrlichiosis in Kenya.

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CHAPTER 1

INTRODUCTION AND REVIEW OF LITERATURE

HISTORY AND GEOGRAPHICAL DISTRIBUTION

The rickettsias are vector-borne obligate, intracellular organisms. They belong in the order Rickettsiales. Their name was derived from that of Dr. H.T. Ricketts who carried out early research on the human rickettsial diseases Rocky Mountain Spotted fever and epidemic Typhus fever (Snyder, 1967). The first report of rickettsiosis in dogs was that of Durand (1932) who infected dogs with *Rickettsia conori* the causative agent of boutonneuse fever in man, now called African tick typhus (Scott, 1978). Ten days after infection the organisms were recovered from the blood. Moshkovskii (1945) proposed the generic name *Ehrlichia* for the rickettsias that infect dogs and this name has been widely accepted (Haig, 1955; Philip, 1974 and Scott, 1978) and will be used in this thesis.

EHRLICHIOSIS IN AFRICA

Canine ehrlichiosis was first reported by Donatien and Lestoquard (1935) from Algeria. The causative agent was identified as *Rickettsia canis* and the disease was called canine rickettsiosis. Donatien and Lestoquard (1936b) compared *R. canis* and *R. conori* in cross-immunity studies and found them to be different. Danks (1937) reported the disease in and around Nairobi in dogs showing pyrexia (107°F), depression, anorexia, rapid emaciation, halitosis, nasal and ocular

discharges. *Babesia canis* could not be demonstrated in the blood smears but rickettsia-like bodies were seen in small lymphocytes and monocytes. Lawrence (1938) diagnosed canine ehrlichiosis in a three month old English Setter from Southern Rhodesia. The first case of canine ehrlichiosis in the Union of South Africa was reported by Neitz and Thomas (1938). This strain of *E. canis* was passaged through 40 dogs, all of which died (Neitz, 1939). Since then there have been many reports of canine ehrlichiosis from South Africa (Malherbe, 1947, 1948; Haig, 1955).

Carmichael (1939) reported canine ehrlichiosis in Uganda. A complicated syndrome caused by a combined infection of *E. canis* and *B. canis* resulted in deaths among European breeds of dogs in the Belgian Congo (Gillain, 1942). The existence of *E. canis* has been reported in the French Congo (Malbrant, 1945), Chad (Receveur and Huagaud, 1949), Tunisia (Bobin, Chabassol, deBrux, Fiehrer, Guillot, Michel and Pigoury, 1962) and Nigeria (Leeflang, 1970; Saror and Pimentel, 1972). Murray (1968) found eleven dogs (4%) with pathological signs of Nairobi bleeding disease in Kenya, but at that stage the etiology of the disease was unknown. Forty years after Danks' report Kaminjolo, Nyindo, Sayer, Rurangirwa, Johnson, Hird, Rosenbaum, Maxie and Ogaa (1976) confirmed the presence of *E. canis* in East Africa, using both cell culture isolation (Nyindo, Ristic, Huxsoll and Smith, 1971) and the indirect fluorescent antibody test (Ristic, Huxsoll, Weisiger,

Hildebrandt and Nyindo, 1972).

EHRLICHIOSIS IN THE AMERICAS

Twenty years after the description of *E. canis* in the old world, Bool and Sütmoller (1957) reported the presence of a similar organism in the dogs on the island of Aruba (Netherland Antilles). Ewing (1963)observed organisms in leucocytes including lymphocytes, monocytes and neutrophils of dogs from Oklahoma, although *E. canis* was not identified until later (Sütmoller, 1964; Ewing 1964). A strain of *E. canis* which was isolated from an indigenous dog in Arkansas differed from earlier strains in that it was only mildly pathogenic (Ewing, Roberson, Buckner and Hayat, 1971). Pierce (1971) described two cases of ehrlichiosis in indigenous dogs from Texas.

Canine ehrlichiosis has been reported from Curacao (Leeflang, 1970), the Virgin Islands, Florida, Puerto Rico (Huxsoll, Hildebrandt, Nims, Amyx and Ferguson, 1970a), Panama (Hildebrandt, Huxsoll, Walker, Nims, Taylor and Andrews, 1973b) and from Brazil (Costa, Silva, Bastista and Guimaraes, 1973). Stephenson, Clothier and Ristic (1975) described the disease in an indigenous dog from Northern Virginia, while Smith, Small, Weisiger, Byerly and Ristic (1975a) isolated *E. canis* from a dog in Illinois which had previously been in India. Stephenson and Ristic (1978) found that a large number of dogs had canine ehrlichiosis in Arizona.

EHRLICHIOSIS IN ASIA AND THE MIDDLE EAST

Mudaliar (1944) first described *E. canis* in India, although Shirlaw (1938) reporting on Lahore Canine Fever in 1938, failed to recognise a mixed infection of *E. canis* and *B. gibsoni (Piroplasma gibsoni)*. Raghavachari and Reddy (1958) found *E. canis* in Hyderabad, while McGaughey, Seneviratna and Mahalingam (1962) reported its presence in Ceylon. Spence, Giam and Theis (1967) claimed that canine ehrlichiosis was present not only in service dogs in Singapore, as reported by Wilkins, Bowden and Wilkinson (1967) but also in imported and locally bred dogs in civilian homes. Seamer and Snape (1970) found *E. canis* in a dog which had been in Aden and the Persian Gulf. Klopfer and Nobel (1972) described an extensive outbreak of canine ehrlichiosis in a large dog kennel in Israel in which only German Shepherd dogs were affected. Willder (1977) reported the disease from a military dog unit in Malaysia; and Davidson, Dill, Tingpalapong, Premabutra, Nguen, Stephenson and Ristic (1978) recorded an epizootic of canine ehrlichiosis among military dogs in Thailand.

DESCRIPTION AND VERTEBRATE LIFE CYCLE OF *EHRLICHIA CANIS*

Rickettsias are classified in the order Rickettsiales, under three families: Rickettsiaceae, Bartonellaceae and Anaplasmataceae. There are 17 genera with 39 recognised species, 19 of which parasitize domestic animals (Scott, 1978).

Ehrlichia canis belongs to the family Rickettsiaceae (Ewing, 1969) and is considered to be representative of the species (Philip, 1974).

Two human pathogens, *Rickettsia rickettsii*, the cause of Rocky Mountain Spotted fever and *R. conorii*, the cause of African tick typhus are maintained and transmitted by a variety of ticks, including ticks which infest dogs and natural infection of dogs with these human parasites has been reported (Scott, 1978). *Ehrlichia equi* can also be transmitted to dogs, but *E. canis* is limited to Canidae (Lewis, 1975, 1976).

Khera (1962) described the rickettsias as a special group of obligate parasitic organisms with certain features in common with bacteria and viruses. They are small, pleomorphic, Gram-negative organisms which stain with aniline dyes and reproduce in living host cells, in which they maintain independent metabolic activity.

Donatien and Lestoquard (1940) described the development cycle of *E. canis* in monocytes following both natural and experimental infections. During the first phase of the disease, initial bodies occurred exclusively in the form of homogenous bodies in the mononuclear cells and stained red with Giemsa stain. Fragmentation of these granules resulted in an accumulation of granules called a morula, which stained purple with Giemsa stain. The elementary bodies developed from these, and they also stain purple but were loosely dispersed throughout the cell. Bool (1959) was only able to confirm two of these

stages, the morulae and elementary bodies.

The *in vitro* studies of Nyindo *et al.* (1971) indicated that *E. canis* underwent a specific cycle of development in the cytoplasm of cells. The first stage observed was the elementary body. Single elementary bodies in the cytoplasm increased in number to form immature cytoplasmic inclusions (initial bodies). The pleomorphic initial bodies varied from 0.5 to 2.5 µ in diameter. Initial bodies developed into morulae, which were larger, oval and clearly demarcated from each other. Many infected monocytes showed an increase to three or four times their normal size and contained as many as 70 intracytoplasmic morulae.

Carter, Seamer and Snape (1971) described two forms of intracytoplasmic inclusions in Giemsa - stained slides from blood and tissues of infected dogs. One form, apparently structureless, consisted of amorphous inclusions which stained the same colour as the nuclei. They were the same size as the morulae and were sometimes found in vacuoles. The second form, consisting of small pleomorphic inclusions of about the same size as the sub-units of morulae were often indistinguishable from those seen in some monocytes of normal dogs.

A relatively high degree of host cell specificity is exhibited by *E. canis* which invades lymphocytes and less commonly monocytes (Ristic, 1978). A new strain of the organism was described by Ewing *et al.* (1971) which parasitized neutrophils and occasionally eosinophils. However, Neitz and Thomas had

observed *E. canis* in neutrophils in 1938. Hayat (1972) compared the pathogenesis of the strains of *E. canis* that occurred in lymphocytes (1962 Oklahoma isolate) with the one occurring in neutrophils and eosinophils (1970 Oklahoma isolate). He found that the former strain produced a more severe disease than the latter. Hayat (1973) later claimed to have seen morulae in the nuclei of peripheral lymphocytes.

Ricksttsias range in diameter from 0.3 to 1.0 microns and are bounded by a rippled three-layered cell wall and a three-layered plasma membrane which contain ribosomes and DNA strands. The tick-borne rickettsias of veterinary interest, grow inside membrane lined vacuoles in the cytoplasm of infected cells, therefore resembling chlamydias (Scott, 1978).

When examined, using the electron microscope, the morulae of *E. canis* were found to be surrounded by a single membrane and consisted of organisms which were either loosely or closely associated with each other (Simpson, 1972b). The inclusion distorted the nucleus and pushed it to the periphery of the cell. The elementary bodies were round (750 nm), ovoid or elongated and surrounded by a double membrane (Simpson, 1972b; Hildebrandt, Conroy, McKee, Nyindo and Huxsoll, 1973a; Smith, Sells, Stephenson, Ristic and Huxsoll, 1976). Replication of these bodies was thought to be by binary fission (Simpson, 1972b).

HOST RANGE OF *EHRLICHIA CANIS*

Apart from the dog, few other species have been infected experimentally with *E. canis*. Donatien and Lestoquard (1937) claimed to have infected a monkey *Macacus inuus*, using larval *Rhipicephalus sanguineus* ticks, while Neitz and Thomas (1938) infected a silver-backed jackal *Canis mesomelas* by intravenous inoculation of infected dog blood. Blood from this infected jackal was subinoculated into dogs 112 days later and parasites were identified. In the USA, Amyx and Huxsoll (1973) infected the American red fox *Vulpes fulva* and the gray fox *Urocyon cinereoargenteus*. In 1964, Ewing, Buckner and Stringer experimentally infected two young coyotes *Canis latrans* with both an *Ehrlichia* species and *B. canis*, and showed that this *Ehrlichia* remained virulent for the dog after passage through the coyote.

Neitz and Thomas (1938) suggested that the wild dog *Lycaon pictus* could serve as a reservoir for *Ehrlichia* species. However, to date, there have been no experimental or field reports to confirm this suggestion. Neitz (1967) reported a fatal case of ehrlichiosis in a silver-backed jackal after exposure to ticks. Harvey, Simpson, Gaskin and Sameck (1979) reported an epizootic of ehrlichiosis in wolves and wolf-dog crosses in Florida. The epizootic was associated with *R. sanguineus* infestation. Attempted transmission of *E. canis* to mice, rats, guinea-pigs, rabbits, hamsters and cats (Ewing, 1969), sheep and cattle (Danks, 1937) or propagation in

embryonating eggs (Huxsoll, Hildebrandt, Nims and Walker, 1970b) were unsuccessful. Two wild cats, a leopard and a lynx were found to have pathological changes similar to Nairobi bleeding disease seen in 11 dogs in Kenya (Murray, 1967), however, at that time the etiology of Nairobi bleeding disease was unknown.

Groves, Dennis, Amyx and Huxsoll (1975) doubted that Donatien and Lestoquard (1937) had sufficient evidence to claim either successful transovarial transmission of *E. canis* through ticks to a monkey or that they were able to infect a monkey with *E. canis*. They suggested that the larvae used in Donatien and Lestoquard's study were not fed on a susceptible dog, but were crushed and inoculated into a monkey. Groves *et al.* (1975) were of the opinion that transfer of an agent by injection or in crushed ticks does not in itself demonstrate a specific vector-parasite relationship. They also argued that the three day incubation period observed in Donatien and Lestoquard's infected monkey was too short when compared with their findings on tick transmitted disease. Secondly, Groves *et al.* (1975) could not infect monkeys with either highly infected canine blood or cell culture material. They also considered that Donatien and Lestoquard did not see the typical morulae in monocytes, nor did they attempt to pass the agent from the monkey back to a susceptible dog. The natural and experimental vertebrate host range of *E. canis* is thus limited to Canidae (Lewis, 1976).

EPIZOOTIOLOGY OF CANINE EHRLICHIOSIS

In 1963, a disease characterised by haemorrhage, severe emaciation, pancytopenia and a high mortality occurred in the British military dogs in Singapore (Huxsoll *et al.*, 1970a). A similar disease also occurred among non-military dogs in Singapore and in British military dogs in the Malayan Peninsula and in Aden (Noble, 1973). During late 1966 and early 1967, the United States Army purchased 30 Labrador Retriever tracker dogs from the British Army in Malaysia. On completion of their training in Malaysia these dogs were transported to Vietnam where they underwent a two week quarantine period. Routine haematological examination revealed that one third of these dogs had pancytopenia. At this time neither the British nor the American army veterinarians recognised the chronic form of canine ehrlichiosis. After this introduction of the disease, an epizootic of a highly fatal haemorrhagic disease spread among the American military dogs in Vietnam (Nims, Ferguson, Walker, Hildebrandt, Huxsoll, Reardon, Varley, Kolaja, Watson, Shrover, Elwell, and Vacura,1971). Between September 1968 and 1970, approximately 180 American military dogs died of this disease (Huxsoll *et al.*, 1970a). Walker, Rundquist, Taylor, Wilson, Andrews, Barck, Hogge, Huxsoll, Hildebrandt and Nims (1970) described the clinical course of this epizootic in S.E. Asia. After the acute phase of the disease, dogs appeared to recover completely but in fact went into a subclinical phase of the disease.

The terminal phase occurred about three months later and consisted of either a syndrome with epistaxis or with severe pancytopenia. Dogs with a prolonged pancytopenia often died showing uraemia. Dogs with acute epistaxis usually died within two to five days while those with chronic disease could have mild, intermittent epistaxis for approximately three months before death

TRANSMISSION OF EHRLICHIA CANIS

Rhipicephalus sanguineus was suggested as the vector of *E. canis* by Donatien and Lestoquard (1936a). Philip (1959) reported that mechanical transmission occurred on transferring a partially-fed male *Haemaphysalis leachii* adult tick from an infected to a normal dog but Ewing (1969) regarded *R. sanguineus* as the only vector. Artificial transmission can be achieved by subcutaneous and intravenous inoculation of infected blood or organ emulsions (Henning, 1948).

Outbreaks of canine ehrlichiosis have usually been associated with severe tick infestation. In kennels where rigid tick control measures were enforced, the disease either disappeared or the prevalence was markedly reduced (Huxsoll, Amyx, Helmelt, Hildebrandt, Nims and Gochenour, 1972). As the vector, *R. sanguineus* is widely distributed throughout the world, inhabiting practically all countries lying between 50°N and 35°S (Scott, 1978), the danger of disease spread by infected dogs is a very real one (Best, Butt and Rohrbach, 1969; Nobel, 1973).

There are various contradictory reports of tick transmissions of *E. canis* in the literature. Amyx and Huxsoll (1973) reported infection of a Beagle with *R. sanguineus* nymphae that had moulted from larvae fed on an experimentally infected gray fox. Donatien and Lestoquard (1937) believed that transovarial transmission of *E. canis* occurred in *R. sanguineus* and that all stages of the tick could transmit the organism. Groves *et al.* (1975) however, showed that only transstadial transmission occurred. They fed larvae on infected dogs which transmitted the disease to susceptible dogs as nymphae and adult ticks. Nymphae which fed on infected dogs were able to transmit the disease to susceptible dogs as adults. However, adult ticks fed on infected dogs did not transmit the infection through their larvae, nymphae or second generation adults. Hence the reservoir of disease for domestic dogs must be chronic carrier dogs and wild canidae (Groves *et al.*, 1975).

Smith *et al.* (1976) showed that although larvae of *R. sanguineus* could transmit *E. canis* as nymphae, pre-feeding of the nymphae was essential for infection if the ticks were to be emulsified and injected into dogs. They also showed the presence of *E. canis* organisms in the midgut and salivary glands by electron microscopy, and in the midgut and haemocytes of ticks by immunofluorescent microscopy. The organisms were not seen in the ovaries. Susceptible dogs were injected with gut tissue and salivary glands from these infected ticks and

they developed ehrlichiosis.

Lewis, Ristic, Smith, Lincoln and Stephenson (1977a) and Smith, Sells, Lewis and Ristic (1978) found that ticks could harbour and transmit *E. canis* for at least 155 days. However, these ticks could only pick up the infection from dogs suffering from the acute febrile phase of the disease (15 to 20 days post infection), when parasites were easily detected in the periphal blood. Ticks that fed on dogs in the subclinical or chronic phase of the disease, did not transmit *E. canis* to other dogs, either naturally or by subinoculation of tick tissues. Since ticks can survive for many months without feeding (158 to 568 days), infected ticks could act as a reservoir for the disease in endemic areas (Lewis *et al.*, 1977a).

Ewing (1969) doubted that intermittently-feeding arthropods such as mosquitoes and fleas would prove to be important mechanical vectors of *E. canis* because at no time in the disease was the parasitaemia high enough in the peripheral blood.

INCUBATION PERIOD AND DURATION OF INFECTION

A febrile reaction is the first indication of disease and occurs 9 to 15 days after inoculation of infected blood into susceptible dogs (Carmichael, 1939; Ewing and Buckner, 1965; Nyindo *et al.*, 1971; Seamer and Snape, 1972; Huxsoll *et al.*, 1972) or the attachment of infected ticks on

susceptible dogs (Lewis *et al.*, 1977a). Hayat and Ewing (1973) found that the mean incubation period of the neutrophilic isolate of *E. canis* was 20.3 days while that of the lymphocytic isolate was 15 days. Morulae of the neutrophilic isolate persisted in the peripheral blood for five to ten days compared to those of the lymphocytic isolate which persisted for 43 to 52 days.

Ewing and Buckner (1965) found that nine months was the longest period in which an uncomplicated infection of *E. canis* persisted in a dog and its blood remained infective for susceptible dogs throughout this period. Another dog lived for 20 months with *B. canis* concurrently present with the *Ehrlichia* for part of that time. In the experience of Huxsoll (1976) the longest period of infection has been five years.

CLINICAL SIGNS OF CANINE EHRLICHIOSIS

Carmichael and Fiennes (1942) described three different forms of canine ehrlichiosis, septicaemic, cutaneous and nervous. Malherbe (1948) found that these forms tended to merge and did not regard them as a rigid classification. The septicaemic form was the most common clinical syndrome (Carmichael and Fiennes, 1942). Marked hyperthermia (107° F) persisted for a week, the temperature then gradually subsided to normal by the 12th day (Malherbe, 1947) or fluctuated for weeks (Carmichael and Fiennes, 1942). Seamer and Snape (1972) recorded a biphasic febrile reaction, with the second temperature rise being higher than the first.

Henning (1948) noticed that the mucous membranes were injected in contrast to the pallor seen in cases of *B.canis* infection. In mixed infections of canine babesiosis and ehrlichiosis, the typical anaemic and icteric mucous membranes of babesiosis were seen. Malherbe (1948) claimed that anaemia was not seen in uncomplicated cases of canine ehrlichiosis. Other clinical signs included serous to mucopurulent nasal and ocular discharge, lethargy,weight loss, rapid emaciation, halitosis (Danks, 1937), vomiting, gastritis, brown deposition on teeth, rapid, hard and thready pulse, lymphadenopathy, splenomegaly, polyuria and pain over the bladder area on palpation of the abdomen (Carmichael and Fiennes, 1942; Ewing *et al.*, 1971; Seamer and Snape, 1972).

Ewing (1969) noticed photophobia and Ellet, Playter and Pierce (1974) studied retinal lesions produced in German Shepherd dogs infected with *E. canis*. There was retinal vascular engorgement during the initial febrile period followed by regression and simultaneous development of perivascular lesions in both tapetal and non-tapetal zones.

The cutaneous form may present two types of lesion. The first was a circumscribed, round, necrotic area, 5 to 7 mm in diameter, which developed at the point of attachment of a tick. The second was an erythemato-pustular eruption which involved the unpigmented areas of the axilla and groin (Carmichael and Fiennes, 1942) while emaciated animals had numerous decubital sores before death (Henning, 1948).

Convulsions, hyperaesthesia , hysteria, meningo-encephalitis and paralysis have been attributed to *E. canis* by Malbrant (1939), while Danks (1937) recorded tremors and a staggering gait in some cases. Carmichael and Fiennes (1942) observed muscular weakness and partial paraplegia in severe cases. Nervous control of the bladder and rectum was completely lost in some of these cases. Coma preceded death in some cases described by Malherbe (1948).

Huxsoll, Hildebrandt, Nims, Ferguson and Walker (1969) found that unilateral or bilateral epistaxis may be accompanied by anorexia, dyspnoea and generalised debilitation. Other clinical signs which may or may not accompany the epistaxis are: anaemia, lethargy, ascites, swelling of one or more joints, oedema of limbs and scrotum, corneal opacity, conjunctivitis and hyphaema, ecchymotic haemorrhages on the abdomen, petechial haemorrhages on the penis, buccal cavity and conjunctiva, melaena, haematuria and prolonged bleeding from injection sites and tick bites (Huxsoll *et al.*, 1970b, 1972; Seamer and Snape, 1972).

Epistaxis was sometimes followed by death within a few days, or by intermittent epistaxis followed by death after several months (Huxsoll *et al.*, 1970b). Dogs with canine ehrlichiosis had a history of pyrexia for about two months which may have been accompanied by anorexia, decreased stamina, severe weight loss and oedema of the limbs. The febrile episode was usually followed by a period of apparent recovery

(subclinical phase), during which the dog appeared normal, but the anaemia, leucopenia and thrombocytopenia persisted. In these dogs, without clinical signs of haemorrhage, death may be due to extensive internal haemorrhage or secondary infections associated with the anaemia and leucopenia (Huxsoll *et al.*, 1972).

Ewing and Philip (1966) concluded, following their work with the Oklahoma strain of *E. canis*, that the high mortality rates mentioned in earlier reports for canine ehrlichiosis were more likely to be due to concomittant babesiosis and ehrlichiosis. The studies carried out by Bool (1959) in the Netherlands, where canine babesiosis was unknown, showed that there, uncomplicated ehrlichiosis was a mild disease. Leeflang and Perie (1972) found that the pathogenicity of Old and New World strains of *E. canis* for susceptible European dogs was similar and that uncomplicated canine ehrlichiosis was a mild disease. These findings are different from those of Huxsoll *et al.* (1970b, 1972) and Nims *et al.* (1971) who reported a highly fatal epizootic of canine ehrlichiosis in Vietnam from 1968 to 1970. Huxsoll (1976) concluded that it was not possible to associate the severe haemorrhagic chronic form of canine ehrlichiosis with strain differences. Using isolates recovered from natural cases of severe chronic ehrlichiosis in experimental studies in Beagles and German Shepherd dogs, they have shown that the differences in disease manifestation were dependent upon breed of dog rather than the strain of organism.

Huxsoll *et al.* (1972) found that most experimentally infected Beagles and cross-bred dogs recovered from the disease, but remained infected. Relapses were characterised by reappearance of earlier signs. They also found that German Shepherd dogs experimentally inoculated with *E. canis* developed a disease that was indistinguishable from the natural disease. The onset of disease resembled that in the Beagle, but was generally more severe. Most German Shepherd dogs survived the initial attack and abnormal haematological signs partially disappeared but relapses frequently occurred (Huxsoll *et al.*, 1972). German Shepherd dogs often developed a severe haemorrhagic syndrome 60 or more days after the initial infection (Huxsoll, 1975). Haemorrhages were associated with severe thrombocytopenia (Huxsoll *et al.*, 1972).

Based on their experimental findings, Burghen, Beisel, Walker, Nims, Huxsoll and Hildebrandt (1971) hypothesised that canine ehrlichiosis began as an acute infection. The invading microorganisms then survived within certain host cells and possibly stimulated a hypersensitivity phenomenon or an autoimmune reaction within the host. After several weeks, this could lead to pancytopenia with erythrophagocytosis within the spleen and lymph nodes, excessive production of serum globulins and glycoproteins, and deposition of immune complexes within the host tissues. This concept was compatible with the fact that antibiotics were useful in treating the acute phase of canine ehrlichiosis but seemed unable to reverse the disease

in its terminal stages. Scott (1978) thought that *E. canis* was responsible for two clinical syndromes, a primary febrile and parasitaemic phase known as canine ehrlichiosis, canine rickettsiosis or canine typhus and an immunologically mediated haemorrhagic complication called canine tropical pancytopenia, Lahore canine fever or Nairobi bleeding disease.

DIAGNOSIS OF CANINE EHRLICHIOSIS

Diagnosis of ehrlichiosis on blood smear examination may be difficult as the parasitaemia is frequently very low (Danks, 1937; Neitz and Thomas, 1938; Ewing, 1969). Malherbe (1947, 1948) found that blood smears made from the first drop of blood that emerged from the tip of the ear, were most satisfactory for demonstration of *E. canis*. If blood smears were made using two glass slides, the white blood cells were mainly concentrated around the feather edge and sides of the smear.

Typical *Ehrlichia* bodies were difficult to find during the first four days after the onset of fever. Although the demonstration of parasites on blood smears was difficult, parasites were more easily seen in smears from the internal organs (Henning, 1948). Huxsoll *et al.* (1969) found cytoplasmic inclusions similar to those of *E. canis* in mononuclear cells in lung, spleen and kidney impression smears from dogs that died of experimental ehrlichiosis. Hildebrandt *et al.* (1973a) and Simpson (1974) found that *E. canis* could be demonstrated more readily from impression smears of lung tissue than from

monocytes in the peripheral blood. Carter *et al.* (1971) reported that when using Giemsa - stained smears from blood and tissues, single rather than multiple morulae of *E. canis* were found in infected cells. These morulae were usually a third or a quarter the size of the host cell nuclei.

Nyindo *et al.* (1971) developed an *in vitro* cell culture technique and they were able to study elementary, initial bodies and morulae of *E. canis* in mononuclear cells. An adaptation of this technique was reported by Kaminjolo *et al.* (1976) in which they used foetal bovine serum in place of canine serum. Stephenson and Osterman (1977) harvested peritoneal macrophages from infected dogs and showed that there was a greater proportion of macrophages (25%) in peritoneal exudate than in peripheral blood leucocytes (5%). *In vitro* cultivation and infection rates of peritoneal macrophages were similar to that of peripheral blood leucocytes.

Carter *et al.* (1971) found that the direct immunofluorescent method was superior to Giemsa staining for the detection of *E. canis* because morulae were more readily detected at a lower magnification. However, the sensitivity of this test did not equal that of infectivity testing by the subinoculation of blood into susceptible dogs. The immunofluorescent technique was used to compare the isolates of *E. canis* from Vietnam, USA and the Middle East and the results showed that the isolates had common antigenic characteristics. However, the test was not sensitive enough to determine whether there was complete antigenic identity

or not (Carter *et al.*, 1971). Ristic *et al.* (1972) described an indirect fluorescent antibody (IFA) test for detecting and titrating antibodies to *E. canis*. This test was applicable to both experimentally infected dogs and field epidemiological investigations.

IMMUNOLOGY OF CANINE EHRLICHIOSIS

Donatien and Lestoquard (1936b) found that recovered cases of canine ehrlichiosis remained latent carriers of *E. canis* and that splenectomy of these dogs resulted in a relapse. Ewing and Philip (1966) showed that *E. canis* was antigenically distinct from *Neorickettsia helminthoeca*, the causative agent of salmon-poisoning disease. Lewis (1975) found that dogs that were experimentally infected with *E. equi* were not protected against subsequent infections with *E. canis*. However, Nyindo, Ristic, Lewis, Huxsoll and Stephenson (1978) showed that ponies which recovered from clinical equine ehrlichiosis were refractory to reinfection with *E. equi*.

Antibody titres in the indirect fluorescent antibody test increased steadily in chronically infected dogs during an 18 month observation period (Buhles, Huxsoll and Ristic, 1974). Weisiger, Ristic and Huxsoll (1975) used ion-exchange and molecular-sieve chromatography and the indirect fluorescent antibody test to study antibody production in experimentally induced cases. Seven days post infection, immunoglobulin M

(IgM) and immunoglobulin A (IgA) antibodies were detected. At 21 days post infection, IgM, IgA and immunoglobulin G (IgG) antibodies were present and thereafter IgG antibodies continued to increase.

Lewis (1977b) studied the effect of serum from uninfected and recovered dogs *in vitro* and found that *Ehrlichia* treated and maintained with normal canine serum multiplied within macrophages in culture but later destroyed them, whereas immune serum from *E. canis* carrier dogs suppressed growth altogether.

Kakoma, Carson, Ristic, Huxsoll, Stephenson and Nyindo (1977) showed that lymphocytes from dogs infected with *E. canis* were cytotoxic for autologous monocytes. The effect was optimal at 100:1 lymphocyte:monocyte ratio. The greatest degree of cytotoxicity coincided with acute ehrlichiosis, the phase which had the lowest platelet count. The platelets increased by day 45 post infection, the beginning of chronic ehrlichiosis. During this phase, cytotoxicity declined. Recovered clinical cases of canine ehrlichiosis continued to harbour *E. canis* in their blood, lungs, liver, spleen and lymph nodes. This persistence of *E. canis* could possibly continue to generate activated cytotoxic lymphocytes.

Ristic and Carson (1978) measured the cell-mediated response using blood leucocytes as a source of sensitized lymphocytes in the leucocyte migration-inhibition test. The cell-mediated response and humoral responses were studied

in twelve German Shepherd dogs and five Beagles, experimentally infected with *E. canis*. They found that 50% of the German Shepherd dogs and 80% of the Beagles were positive in the peripheral blood leucocyte migration-inhibition test and that all dogs developed strong anti - *E. canis* antibody titres in the indirect fluorescent antibody test.

TREATMENT AND PROPHYLAXIS OF CANINE EHRLICHIOSIS

Pasquini (1939) reported the successful treatment of five cases of canine ehrlichiosis with two intravenous injections of 10 ml of saline mixed with seven to ten drops of formalin at a 48 hour interval. Sulphapyridine used as an initial intravenous dose followed by four daily, oral treatments have also been s shown to be effective in treatment of canine ehrlichiosis (Malherbe, 1948). Haig (1955) found that sulphadimidine was the most effective of the sulphonamides but noticed that relapses were common five to six days after treatment. Bool and Sütmoller (1957) showed that sulphapyridine and sulphamethazine were only effective in the early stages of the disease.

Six out of seven cases of canine ehrlichiosis were successfully treated with daily treatments of oral chlortetracycline hydrochloride (Aureomycin) (Cassard, 1957) while the use of oxytetracycline and sulphadimidine resulted in the slow recovery of an uncomplicated case (McGaughey *et al.*, 1962). Buckner and Ewing (1967) showed that while neither chloramphenicol, procaine penicillin G, sulphadimethoxine, nor

sulphacetamide were effective in eliminating *E. canis*, oxytetracyclines at 22 mg per kg , given in daily oral doses for 14 days resulted in apparent clinical recovery. However, Walker *et al.* (1970) found that tetracyclines were effective in the initial febrile period but not in the terminal stages of canine ehrlichiosis. They found that vitamin B Complex helped overcome anorexia, and intramuscular dexamethasone was beneficial in controlling initial epistaxis. They also found that penicillin, streptomycin, erythromycin, blood transfusions and haemostatic drugs were ineffective in the treatment of the disease. Leeflang (1971) used 10 mg per kg body weight of oxytetracycline for five consecutive days to sterilise the blood of *Ehrlichia* carrier dogs; however, these dogs could be re-infected 24 hours after treatment. Amyx *et al.* (1971) treated clinical stages of the disease in experimentally infected Beagles and German Shepherd dogs with tetracycline hydrochloride at 30 mg per lb daily for 14 days, administered orally in divided doses. Thirty days later, the dogs were sucessfully re-infected with *E. canis*. The second infection was as severe as the first. They also showed that daily oral tetracyclines at 3 mg per lb body weight could be used prophylactically. Seamer and Snape (1972) used 12.5 mg per lb of oxytetracyclines, twice daily, in the food also as a prophylactic, but the dogs were susceptible to infection when the special diet was stopped.

Both Amyx *et al.* (1971) and Seamer and Snape (1972) suggested that prophylaxis with oxytetracyclines may be the

only means of protecting dogs in areas with a high incidence of canine ehrlichiosis. Amyx *et al.* (1971) emphasised that since tetracyclines were rickettsiostatic and not rickettsiocidal the duration of treatment was very important. Willder (1977) used daily oral tetracycline hydrochloride at 3 mg per lb body weight to prevent canine ehrlichiosis in susceptible dogs in Malaysia. After four years treated dogs showed no clinical evidence of the disease, no side effects from continuous antibiotic ingestion and no impairment of training or working. He also reported that dogs on prophylactic tetracyclines showed no impairment of conception, gestation, parturition, lactation, litter size or litter health. Davidson *et al.* (1978) controlled an epizootic of canine ehrlichiosis in Thailand by therapeutic (66 mg per kg for 14 days) and prophylactic (6.6 mg per kg daily) use of tetracyclines and by strict control of ticks.

Parenteral oxytetracycline at 10 mg per kg for ten days resulted in prompt remission of clinical signs and an improvement in haematological parameters, but most dogs remained "poor doers" and relapsed in spite of treatment (Immelman and Button, 1973). Parenteral chloramphenicol at 10 mg per kg was not a successful treatment (Immelman and Button, 1973).

Seamer and Snape (1972) used intravenous injections of ethoxyethylglyoxal dithiosemicarbazone (gloxazone 356C61), at 10 mg per kg in three cases of canine ehrlichiosis. This treatment, given during the incubation period of the disease, considerably delayed the onset of clinical signs. After this

initial delay, the course of infection in treated dogs did not differ from that of untreated dogs.

Adeyanju and Aliu (1977) reported the successful treatment of 26 out of 31 dogs (84%) with a single intramuscular injection of 12% imidocarb dipropionate at 5 mg per kg body weight.

CLINICAL PATHOLOGY OF CANINE EHRLICHIOSIS

During the febrile reaction of canine ehrlichiosis, Henning (1948) and Haig (1955) noticed a marked monocytosis with many atypical monocytes and an eosinopenia. Huxsoll *et al.* (1969) found that severe anaemia, leucopenia and thrombocytopenia occurred. Walker *et al.* (1970) noted that dogs with canine ehrlichiosis had a marked leucopenia at death and counts of below 1 000 per cu mm were seen in many dogs with epistaxis. Leucocyte counts rarely exceeded 6 000 per cu mm even in dogs with overwhelming secondary bacterial infections. The differential leucocyte counts were within normal limits. They also found that dogs with pancytopenia had macrocytic anaemia while those with epistaxis had a normocytic anaemia. Dogs with a leucocyte count of less than 7 000 per cu mm or a haematocrit value of less than 37% or both were classified as *Ehrlichia*-suspects in the epizootic in S.E.Asia (Nims *et al.*, 1971).

The first haematological sign of *E. canis* infection in Seamer and Snape's (1972) experimental dogs was a dramatic thrombocytopenia. Platelet counts usually fell to below

100 000 per cu mm by the 14th day post infection and persisted at low levels for long periods of time. Morphological changes in platelets, including an increase in size, were noticed on stained peripheral blood smears. Thrombocytopenia and megathrombocytes were also recorded by Hayat (1973). The least striking haematological change recorded by Seamer and Snape (1972) was the gradual decrease in leucocyte counts. Total counts fell to below 8 000 per cu mm by the third or fourth week after infection and then gradually increased. During the acute stage of infection, eosinopenia and monocytosis were noticed. In four cases of uncomplicated canine ehrlichiosis, Lawrence and Efstratio (1973) noticed the presence of anaemia and moderate leucopenia with a relative monocytosis and eosinopenia.

Pierce, Marrs and Hightower (1977) found a biphasic pattern in the decrease of platelets in experimental infections. There was a gradual decrease in circulating platelets for ten days post infection followed by a rapid decline for four to six days. Thereafter their findings were similar to those of Seamer and Snape (1972) and Hayat (1973). Megathrombocytes were evident in the circulation by Day 14 post infection and were over eight times normal by 21 and 28 days post infection. This indicated accelarated thrombocytopoiesis as well as megakaryocytopoiesis.

Using phosphorus-32-labelled blood platelets, Smith, Hooks, Huxsoll and Ristic (1974) showed that platelet destruction in the acute phase of the disease was fast enough to account for the thrombocytopenia seen during acute ehrlichiosis. However, the

reduction in platelet survival in chronically infected dogs was not sufficient to explain the degree of thrombocytopenia in chronic ehrlichiosis. They suggested that bone marrow hypoplasia may be involved in the pathogenesis of the disease. Smith, Ristic, Huxsoll and Baylor (1975b) supported this theory with their work on platelets, using selenomethionine. They showed that platelet destruction occurred at an increased rate during canine ehrlichiosis and was the primary cause of thrombocytopenia. Bone marrow cellularity was related to the severity of the clinical signs. Thus a haemorrhagic crisis occurred when the bone marrow was no longer capable of compensating for increased platelet destruction. They also suggested that exhaustion of thrombocyte stem cells in chronically infected dogs might explain the finding that tetracycline therapy initiated late in the disease syndrome was often followed by a delayed return of platelet numbers to normal. In contrast, treatment of dogs in the acute phase of the disease resulted in rapid return of platelet numbers to normal.

Buhles *et al*. (1974) showed in their series of experiments that the pathogenesis of acute canine ehrlichiosis was different from that of the severe chronic disease. They claimed that in the acute disease, the normal or hypercellular bone marrow together with the peripheral blood pancytopenia indicated increased sequestration or destruction of blood cell elements. In the severe chronic form, the bone marrow hypoplasia indicated decreased regeneration of blood cell elements.

The coagulation and prothrombin times were normal, while the bleeding time was prolonged. The erythrocyte sedimentation rate was often elevated and an increase in blood urea nitrogen was noticed in long standing cases (Huxsoll *et al.*, 1970b; Seamer and Snape, 1972; Simpson, 1972a; Immelman and Button, 1973). Walker *et al.* (1970) found normal bilirubin values indicating a non-haemolitic anaemia, and dogs in the terminal phase of ehrlichiosis had significantly increased blood urea nitrogen levels.

Burghen *et al.* (1971) reported an increase in the gammaglobulin fraction and a decrease in the albumin fraction of the plasma in dogs with canine ehrlichiosis. This was confirmed by Buhles *et al.* (1974) and Weisiger *et al.* (1975). Burghen *et al.* (1971) studied the changes in serum protein fractions from dogs with naturally acquired canine ehrlichiosis in the terminal stages of the disease (pancytopenia and /or epistaxis) and those with acute disease. They found that in chronic ehrlichiosis, serum protein changes were characterised by a marked decrease in serum albumin and a correspondingly high increase in gammaglobulin and gammaglycoglobulin.

PATHOLOGY OF CANINE EHRLICHIOSIS

Hildebrandt *et al.* (1973b) reported on 100 cases of canine ehrlichiosis that died or were euthanised in the S.E. Asian outbreak. They found that a few dogs had circular areas of moist dermatitis and oedema of limbs which had a purplish discolouration of the affected skin. These dogs had a rough,

dry coat. Malherbe (1974) also noticed occasional erosions of the skin whereas van Dijk (1971) rarely noted skin changes. The carcases were emaciated with very little subcutaneous fat (van Dijk, 1971; Hildebrandt *et al.*, 1973b). Subcutaneous tissue and musculature were often pale (Danks, 1937; Ewing, 1969) and oedematous areas were filled with clear, gelatinous fluid and engorged blood vessels (Hildebrandt *et al.*, 1973b). Haemorrhages occurred over bony prominences and large subcutaneous haemorrhages were present over the trunk, occasionally extending between muscle layers (Huxsoll *et al.*, 1970b; Hildebrandt *et al.*, 1973b).

A mucoid or mucopurulent discharge was present at the external nares and in the conjunctival sac (Ewing, 1969) Haemorrhages were seen at the nares and petechiae on the gingivae and conjunctivae. The turbinates were mildly hyperaemic (Hildebrandt *et al.*, 1973b).

Huxsoll *et al.* (1970a) and van Dijk (1971) reported generalised lymphadenopathy as a prominent feature of canine ehrlichiosis but Ewing (1969) found that lymph nodes were rarely enlarged. Cross sections of affected nodes were reddish-brown in colour (Huxsoll *et al.*, 1970a; Hildebrandt *et al.*, 1973b) or grey white with distinct follicles which were increased in number (van Dijk, 1971) and were excessively moist (Danks, 1937; Ewing, 1969; van Dijk, 1971). The spleen was enlarged (Danks, 1937; Ewing, 1969; Huxsoll *et al.*, 1970a; van Dijk, 1971), had a turgid capsule, was reddish-purple in colour and had prominent

Malpighian corpuscles (Ewing, 1969). Peyer's patches and lymphoid follicles of the intestinal mucosa were normal in size or enlarged (Ewing, 1969). Occasionally, the tonsils were enlarged, everted from the crypts, and covered with a greyish fibrinous exudate (Hildebrandt *et al.*, 1973b).

Hildebrandt *et al* (1973b) found that gastrointestinal lesions were frequent, ranging from slight congestion to large serosal and mucosal haemorrhages and free blood in the intestinal lumen. Danks (1937) and Malherbe (1947) reported catarrhal enteritis with haemorrhages and ulceration, whereas Ewing (1969) did not find ulceration in the intestine.

The liver was usually pale and occasionally icteric (Ewing, 1969; Hildebrandt *et al.*, 1973b) or enlarged (Malherbe, 1947; van Dijk, 1971). Petechial and ecchymotic haemorrhages were also seen in the wall of the gall bladder (Hildebrandt *et al.*, 1973b). Danks (1937) found that the kidneys showed the most marked lesions. They were mottled in appearance, having numerous scattered pale areas. Petechiae were occasionally present in the renal cortices and urinary bladder mucosa (Ewing, 1969). Hildebrandt *et al*. (1973b) found that approximately 50 of the dogs examined had haemorrhages somewhere in the urogenital system, most frequently involving the mucosal and serosal surfaces of the urinary bladder. There were subcapsular haemorrhages and focal haemorrhages near the corticomedullary junction of the kidney. Petechial haemorrhages were also present in the prostate, testicle and epididymis.

Of the 100 cases examined by Hildebrandt *et al.* (1973b) the most frequent lesions encountered were cardiac and pulmonary haemorrhages. These cardiac haemorrhages were on both the epicardium and endocardium and varied considerably in size. Ewing (1969) found that the arterioventricular valve cusps were sometimes thickened. The lungs were found to be oedematous (Malherbe, 1947; Ewing, 1969) with a distinctive exudative bronchopneumonia in a few cases (van Dijk, 1971).

The femoral bone marrow was greyish-red and relatively firm (Ewing, 1969) with little fat present centrally and obvious haemopoiesis between the fat cells (van Dijk, 1971). There was a consistent predominance of myelopoiesis over erythropoiesis (van Dijk, 1971). A few dogs had hyphema and corneal opacity (Hildebrandt *et al.*, 1973b). Ewing (1969) and van Dijk (1971) did not observe gross lesions in the brain or cerebral meninges but Hildebrandt *et al.* (1973b) observed haemorrhages in the cranial and spinal dura mater of a few dogs. Microscopically, van Dijk (1971) reported proliferative, disseminated pan-encephalitis with distinct swelling and proliferation of the endothelium and the perivascular tissue. There was lymphoplasmacellular meningitis which varied from being local with normal cells to more diffused with increased numbers of cells.

Huxsoll *et al.* (1970a) and Robinson and Garner (1973) found that there was perivascular plasma cell and lymphocyte infiltration in the meninges, lungs, spleen, lymph nodes,

kidneys and retina of the eye which became progressively more severe. With prolonged disease there was centrilobular necrosis of the liver and bone marrow hypoplasia.

In a histopathological survey of 2 500 German Shepherd military working dogs, Robinson and Garner (1973) found that from the cases in which a post-mortem diagnosis was made, ehrlichiosis was responsible for 18% of dogs that died and 23% of those that were euthanised.

This study was undertaken to determine:

a) The clinical signs of canine ehrlichiosis with special reference to the breed predilection;

b) whether tetracyclines were really as effective a treatment as they were documented to be or was there a better drug available;

c) whether any of the free living members of the canine species in Kenya also carried *E. canis*.

CHAPTER 2

NATURALLY OCCURRING CASES OF CANINE EHRLICHIOSIS

Soon after Donatien and Lestoquard (1935) described canine ehrlichiosis in Algeria, Danks (1937) described an outbreak of severe disease in Kenya which was called Nairobi bleeding disease. The clinical signs included pyrexia, depression, anorexia, rapid emaciation, halitosis and nasal and ocular discharge. *Babesia canis* could not be demonstrated on stained blood smears, but *Ehrlichia canis* bodies were detected.

Many reports record concomittant babesiosis and ehrlichiosis as a severe and often fatal disease (Danks, 1937; Huxsoll *et al.*, 1970a, 1972; Walker *et al.*, 1970; Nims *et al.*, 1971), yet uncomplicated ehrlichiosis appeared to be a mild condition (Bool, 1959; Ewing and Philip, 1966; Leeflang and Perie, 1972). Additional clinical signs of canine ehrlichiosis reported include: injected mucous membranes (Henning, 1948), vomiting, rapid, hard and thready pulse, lymphadenopathy, splenomegaly, polyuria (Carmichael and Fiennes, 1942; Ewing *et al.*, 1971; Seamer and Snape, 1972), photophobia (Ewing, 1969), necrotic and erythemato-pustular skin lesions (Carmichael and Fiennes, 1942), muscular weakness, partial paraplegia (Carmichael and Fiennes, 1942), convulsions, hyperaesthesia, meningoencephalitis, paralysis (Malbrant, 1939), unilateral or bilateral epistaxis (Huxsoll *et al.*, 1969), ascites, swelling of joints, oedema of limbs and

scrotum, corneal opacity, hyphaema, ecchymotic haemorrhages on the abdomen, petechial haemorrhages on the mucosae of the penis, buccal cavity and conjunctiva, melaena, haematuria, prolonged bleeding from injection sites and from tick bites (Huxsoll *et al.*, 1970b, 1972; Seamer and Snape, 1972).

The only known vector of *E. canis*, *Rhipicephalus sanguineus* (Donatien and Lestoquard, 1936a; Groves *et al.*, 1975) is widely distributed throughout Kenya (Walker, 1974), where it is found from sea-level to an altitude of 2 100 metres, in forest, woodland, bushland and bushed grass-land, with annual rainfall ranging from less than 250 mm to over 1 300 mm and in both humid and arid conditions. Therefore a situation for the establishment and transmission of canine ehrlichiosis exists throughout much of Kenya.

Forty years after Danks' report, Kaminjolo *et al.* (1976) confirmed the presence of *E. canis* in Kenya using a blood mononuclear cell culture technique (Nyindo *et al.*, 1971) and the indirect fluorescent antibody test (Ristic *et al.*, 1972). Since then, modifications of the mononuclear cell culture technique originally described by Nyindo *et al.* (1971) have been used routinely at the Small Animal Clinic of the Faculty of Veterinary Medicine, University of Nairobi, to detect the presence of *E. canis* in dogs that were showing clinical signs suggestive of the infection and to detect asymptomatic carriers. Clinical signs and haematological findings were similar to those described in other countries.

MATERIALS AND METHODS

Source and Examination of Cases

The naturally occurring cases of canine ehrlichiosis described were presented at the clinic. During a 20 month period, from January 1978 to September 1979, a total of 9 000 canine accessions were examined at the clinic; of these, 750 cases of canine ehrlichiosis were diagnosed by five veterinary surgeons on the staff. These cases came mainly from within a 25 km radius of Nairobi, with a few from elsewhere in Kenya.

Cases were examined in detail, in that all body systems were examined. In all presenting cases where the body temperature was elevated, or where clinical signs suggested either *B. canis* or *E. canis*, a peripheral blood smear from the capillary circulation (ear tip) was prepared, air dried, fixed with methanol, stained with Giemsa and examined at 1 000 times magnification under oil immersion for the presence of blood parasites. Detailed records of 373 dogs from the total 750 cases of ehrlichiosis were used to compile a list of presenting signs, clinical and haematological findings and information on response to treatment. All clinical parameters were not recorded in every case and 111 (30%) of these dogs were not returned to the clinic for follow up examination after treatment for the disease.

The dogs in this study were divided into three groups; pure-bred dogs (excluding German Shepherd dogs), German Shepherd dogs and cross-bred dogs. The German Shepherd dogs were placed

in a group on their own in order to ascertain whether they were more susceptible to *E. canis* infection, showed special clinical signs or reacted in a different way from other pure-bred dogs as has been found by other workers (Huxsoll *et al.*, 1972; Huxsoll, 1976).

Blood Mononuclear Cell Culture Technique

A modification of the blood mononuclear cell culture technique described by Nyindo *et al.* (1971) was used routinely to confirm the diagnosis of canine ehrlichiosis. The hair over the jugular or cephalic vein was clipped and the skin cleaned with Chlorhexidine [a]. Ten millilitres of whole blood from either vein were drawn into a sterile heparin-coated plastic syringe and the needle discarded. A second needle was applied, the shaft bent at right angles and the syringe taped to the wall in an upright position (Figure A). Particular care was taken to allow the blood to settle undisturbed for 30 to 60 minutes, after which 2 ml of plasma were carefully transferred through the bent needle into two sterile Leighton tissue culture tubes, containing glass coverslips (5 X 22 mm) (Figure B). These tubes were incubated at 37°C for 48 hours after which the cells on the coverslip within one of the tubes were washed with 0.9% saline, fixed with methanol and stained with Giemsa. The coverslip was then removed from the tube and mounted onto a

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[a] Hibitane solution - Imperial Chemical Industries, Ltd., Pharmaceuticals Division, Cheshire, Great Britain.

N.B. (Hibitane solution was mixed with alcohol).

FIGURE A

BLOOD MONONUCLEAR CELL CULTURE TEST

A HEPARINISED SYRINGE CONTAINING 10 ml OF BLOOD,

TAPED TO THE WALL IMMEDIATELY AFTER COLLECTION

AND ERYTHROCYTES ALLOWED TO SETTLE

FIGURE B

BLOOD MONONUCLEAR CELL CULTURE TEST

THE NEEDLE BEING INTRODUCED INTO THE STERILE LEIGHTON TUBE. BY APPLYING PRESSURE TO THE SYRINGE PLUNGER, 2 ml OF PLASMA WERE THEN TRANSFERRED INTO THE TUBE

glass microscope slide using a mounting medium [b]. The mononuclear cells were then carefully searched microscopically, using a 1 000 times magnification oil immersion lens, for the presence of purple staining morulae of *E. canis* in the cytoplasm of the cells, as has been described by Nyindo *et al.* (1971). If this proved negative, the coverslip from the second tube was examined, following incubation for 96 hours. The same procedure was used. Culture medium or antibiotics were not added to the Leighton tubes during incubation.

Haematological Analysis

Two millilitres of whole blood were collected in a bottle containing 4 mg ethylenediaminetetraacetic acid (EDTA) - disodium salt, for routine haematological tests. Packed cell volume was established using the microhaematocrit method (Benjamin, 1961). Haemoglobin values were determined with a haemoglobinometer[1]. A refractometer[2] was used to determine total plasma proteins. The red blood cell count, leucocyte count, mean cell volume and mean cell haemoglobin concentration were estimated using an

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[b] Depex Mounting Medium - dilute 3:1 with Xylol. Searle Diagnostic, High Wycombe, Bucks., England.

[1] Haemoglobinometer - Coulter Electronics Inc., Hialeah, Florida, USA.

[2] Refractometer - Atago, Japan.

electronic particle counter [3]. Differential leucocyte counts were made from Giemsa or Wright - stained blood smears using the battlement method (Schalm, Jain and Carrol, 1975). Platelets were counted by the direct method (Schalm *et al.*, 1975). Bone marrow smears were obtained by the Meyer and Bloom (1943) aspiration technique and stained with Wright's stain.

Serum Biochemical Analysis

Ten millilitres of whole blood were collected into a plain glass tube, allowed to clot and the serum used for biochemical analysis. Blood urea nitrogen level was estimated using the Urastrat [4] impregnated paper method; calcium by Webster's method (1962); alkaline phosphatase by King and Armstrong's method (1934); serum glutamic pyruvic transaminase by Reitman and Frankel's method (1957) and serum total protein, albumin and globulin by the biuret method (Varley, 1969).

Cerebrospinal fluid was collected from the cerebello-medullary cistern of dogs, using the method described by De Lahunta (1977).

Post-mortem examinations were carried out according to necropsy procedures described by Coffin (1954). Specimens were

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[3]Coulter Counter - Model Z_B Coulter Electronics Inc., Hialeah, Florida, USA.

[4]Urastrat - General Diagnostics, Warner-Lambert Company, Morris Plains, New Jersey 07950, USA.

routinely fixed in 10% formal saline for histological examination. Formalin fixed specimens were processed according to the Manual of Histologic and Special Staining Technics (Anon., 1960), sectioned at 5 u thick and routinely stained with haematoxylin and eosin for microscopic examination.

RESULTS

Cases of canine ehrlichiosis were presented with a wide spectrum of history and clinical signs. The major clinical signs presented by the 373 dogs in this study are given in Table 1. From this table it can be seen that the German Shepherd dogs did not behave differently from the other pure-bred dogs or the cross-bred dogs. This is particularly noticeable as far as the bleeding or haemorrhagic signs are concerned.

The cases presented could be conveniently grouped according to the major presenting clinical signs and haematological changes, but there was a considerable degree of overlap. The groupings were as follows: acute ehrlichiosis, ehrlichiosis with frank haemorrhagic signs, ehrlichiosis associated with abnormalities of the central nervous system, ehrlichiosis with babesiosis, ehrlichiosis with uraemia, ehrlichiosis causing breeding abnormalities, subclinical ehrlichiosis, healthy carrier state and chronic ehrlichiosis. Individual cases representing the characteristics of these groups are presented.

TABLE 1

INCIDENCE OF CLINICAL SIGNS OF PURE-BRED DOGS, GERMAN SHEPHERD DOGS AND CROSS-BRED DOGS SUFFERING FROM CANINE EHRLICHIOSIS

		PURE-BRED	GERMAN SHEPHERD	CROSS-BRED
TOTAL NUMBER		160	107	106
WEIGHT LOSS		49	38	26
TEMPERATURE	- Pyrexia	43	36	29
	- Normal	64	42	39
APPETITE	- Selective	33	27	20
	- Anorexia	28	22	32
	- Normal	22	14	8
DEMEANOUR	- Depressed	54	25	36
	- Normal	7	5	1
SPLEEN	- Enlarged	54	42	24
	- Normal	26	14	11
MUCOUS MEMBRANES	- Pale	48	32	34
	- Congested	10	15	6
	- Normal	[illegible]	[illegible]	19
INTESTINAL PROBLEMS	- Vomiting	16	8	13
	- Diarrhoea	5	10	5
BLEEDING ABNORMALITIES		27	15	20
BREEDING ABNORMALITIES		7	2	0
CONCURRENT BABESIOSIS		26	23	26

N.B. The figures in Table 1 are taken from the clinical records of these dogs. Not all parameters were determined in every case.

Acute Ehrlichiosis

The more acute cases of ehrlichiosis usually presented with a sudden onset of depression, anorexia, pyrexia and vomiting. Pale or congested mucous membranes, splenomegaly and lymph node enlargement were present on physical examination. Since many of these signs were those shown by dogs with canine babesiosis, a Giemsa - stained peripheral blood smear was carefully searched for the presence of *B. canis* and *E. canis*. The former being readily detected in most cases while the latter were rarely found even in cases which later proved positive on blood mononuclear cell culture.

Ehrlichiosis with Frank Haemorrhagic Signs

The classical signs of haemorrhage in canine ehrlichiosis were seen in representatives of most of the dog breeds brought to the clinic (Table 1). These signs included petechial and ecchymotic haemorrhages in the visible mucous membranes of the mouth (Figure C), vulva and prepuce, in the relatively hairless areas of the skin on the abdomen (Figure D) and pinna of the ears, on the iris (Figure E) or under the conjunctiva (Figure F). Frank bleeding was seen in the form of epistaxis (Figure G), haematuria, haematemesis and blood in the faeces (either melaena or fresh blood). Prolonged bleeding from injection sites or during routine surgery and from minor surgical procedures such as claw clipping were also possible indications of canine ehrlichiosis. These signs either appeared suddenly with no other complaint or detectable abnormality or were seen in other cases which were in

FIGURE C

CASE 18513. NATURALLY OCCURRING CANINE EHRLICHIOSIS

PETECHIAL HAEMORRHAGES IN THE MUCOUS MEMBRANES

OF THE MOUTH OF A NATURALLY OCCURRING CASE

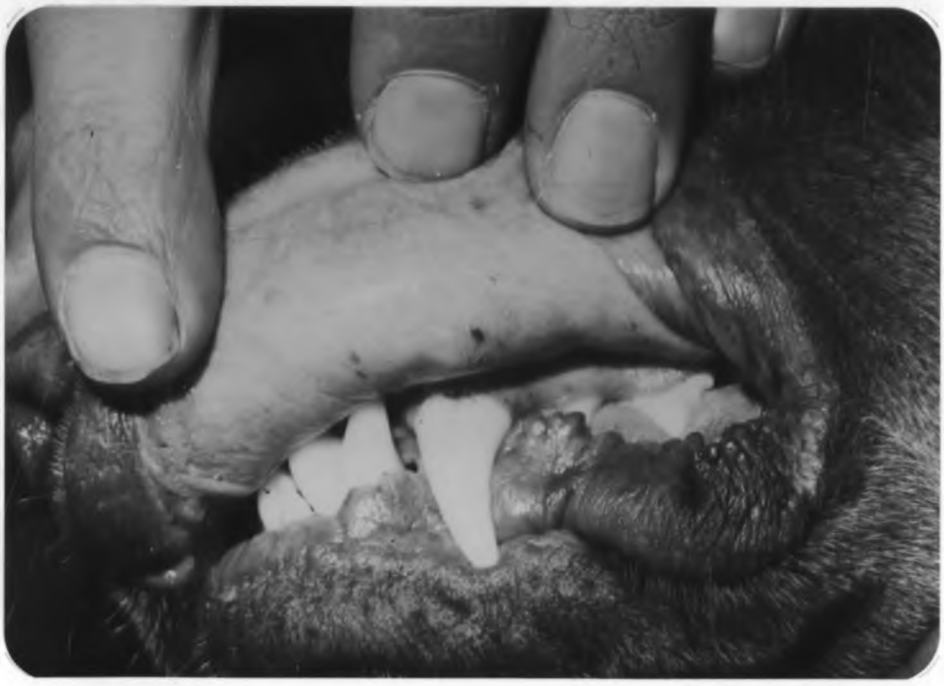

FIGURE D

NATURALLY OCCURRING CANINE EHRLICHIOSIS

PETECHIAL AND ECCHYMOTIC HAEMORRHAGES ON THE ABDOMEN OF A NATURALLY OCCURRING CASE

FIGURE E

NATURALLY OCCURRING CANINE EHRLICHIOSIS

IRIS HAEMORRHAGES AND OCULAR DISCHARGE

OF A NATURALLY OCCURRING CASE

FIGURE F

NATURALLY OCCURRING CANINE EHRLICHIOSIS

HAEMORRHAGE OF THE SCLERA OF A

NATURALLY OCCURRING CASE

FIGURE G

NATURALLY OCCURRING CANINE EHRLICHIOSIS

UNILATERAL EPISTAXIS IN A

GERMAN SHEPHERD DOG

a state of collapse. Dogs with the foregoing signs were found to harbour *E. canis* and responded dramatically to treatment with tetracycline hydrochloride and steroids in most cases. One such cases was Case 18513 which is used to illustrate the characteristics of this clinical group.

Case 18513 was a three year old male Weimeraner, from Nyahururu, which is 198 km from Nairobi, at an altitude of 2350 m, where the dog had lived all its life. It suddenly developed epistaxis and haemorrhages on the skin of the abdomen and in the eye with no previous or other accompanying signs of illness. The appetite was normal. In the absence of a veterinary surgeon, a physician had treated the dog with injectable penicillin and steroids for three days and then referred the case to the clinic.

On physical examination, the dog showed petechiation of the mucous membranes of the mouth and gums (Figure C), although the gums were pink in colour. There were large haemorrhages on the iris of the left eye (Figure E) and splenomegaly. No parasites were seen on stained peripheral blood smears, however, the cell culture test was positive for *E. canis*. The packed cell volume and leucocyte count were within normal levels, however, the thrombocytes were 52 000 per cu mm (Table 2).

Treatment was initiated immediately with oral tetracycline hydrochloride at 66 mg per kg, for 14 days. Since the dog lived a long way from the clinic, it was not returned for reassessment,

TABLE 2

EHRLICHIOSIS WITH HAEMORRHAGIC SIGNS

CLINICAL HAEMATOLOGY AND SERUM BIOCHEMISTRY OF CASE 18513

PARAMETER	DAY O
Packed cell volume (%)	42
Haemoglobin (g/100 ml)	14.2
Erythrocytes X $10^6/mm^3$	6.69
Nucleated erythrocytes (%)	-
Platelets X $10^3/mm^3$	52 000
Leucocytes/mm^3	18 700
Neutrophils/mm^3	17 017 (91%)
Lymphocytes/mm^3	1 496 (8%)
Monocytes/mm^3	-
Eosinophils/mm^3	187 (1%)
Mean cell volume (mm^3)	60
Mean cell haemoglobin concentration (%)	34.1
Urea nitrogen (mg/100 ml)	25
Phosphorus (mg/100 ml)	-
Alkaline phosphatase (King Armstrong units)	5.8
Serum glutamic phosphoric transaminase (Reitman Frankel units)	-
Total protein (g/100 ml)	6.65
Albumin (g/100 ml)	3.40
Globulin (g/100 ml)	3.25
Albumin/Globulin ratio	1.05

Figures in parentheses are the relative distribution of leucocytes. The urea nitrogen, alkaline phosphatase and the proteins are within normal values.

however, it was reported to have improved after treatment and the haemorrhages in the iris and mucosae to have faded slowly.

Ehrlichiosis Associated with Abnormalities of the Central Nervous System

Eleven dogs showed signs indicating involvement of the central nervous system, probably due to haemorrhage within the spinal column. One or more of the following signs were noted in dogs from this group: arched back, severe pain in the neck or back, hind leg paresis or sudden collapse. No abnormalities of the spinal column could be detected by radiological examination. However, *E. canis* could be cultured from these cases and they responded clinically to treatment with tetracycline hydrochloride and steroid therapy. It proved difficult to confirm such spinal haemmorrhage since it was not always justifiable to subject these cases to the risk of general anaesthesia for cerebrospinal fluid collection. When cerebrospinal fluid was collected the red cell count was equivocal. The presence of frank blood in the fluid suggested a sampling fault while negligible changes in red blood cells merely indicated that any haemorrhage or capillary leak might be within the parenchyma of the cord and not into the subarachnoid space. Attempts to culture the causal organism from the cerebrospinal fluid were not successful. Case 10140 is a case which showed signs of central nervous system abnormality.

Case 10140 was a ten and a half year old, male Labrador which had been anorexic for 24 hours. The body temperature was 38.8°C and there was enlargement of the mandibular lymph nodes

and spleen. Parasites were not seen on stained peripheral blood smears, however, the cell culture test was positive for *E. canis*. The dog was treated with tetracycline hydrochloride, twice daily, for 14 consecutive days.

Five days after the start of the above treatment (Table 3, Day 5), the dog was returned to the clinic because it again had not eaten for 24 hours and was depressed and dull. The body temperature was 39°C, the mucous membranes were pink and the pulse rate was 130 per minute. The respiratory rate was increased (60 per minute) with harsh respiratory sounds audible on the right side of the chest. Since no blood parasites were found on a Giemsa - stained peripheral blood smear, the tetracycline hydrochloride was continued.

From Table 3 (Day 6) it can be seen that six days after treatment was started, the blood parameters were still well within normal levels. However, the next day, the dog was still anorexic and now unable to use his hind legs. The following day, the dog was recumbent. On Days 9 and 10 the dog was treated with steroids in addition to tetracycline hydrochloride. He had improved by the following day, was eating and able to walk a little although he was still very weak. Treatment with steroids and tetracyclines were continued over the next four days during which time the dog resumed normal walking and eating habits.

This dog was seen at the clinic a number of times over the next twelve months for other conditions, but no relapse of this

TABLE 3

EHRLICHIOSIS WITH NEUROLOGICAL SIGNS

CLINICAL HAEMATOLOGY AND SERUM BIOCHEMISTRY OF CASE 10140

PARAMETER	DAY 0	DAY 6	DAY 13
Packed cell volume (%)	52	55	39
Haemoglobin (g/100 ml)	17.6	18.6	13.4
Erythrocytes X $10^6/mm^3$	7.97	8.19	5.58
Nucleated erythrocytes (%)	-	-	-
Platelets X $10^3/mm^3$	Normal	-	-
Leucocytes/mm^3	9 100	7 500	12 100
Neutrophils/mm^3	6 370 (70%)	5 700 (76%)	8 470 (70%)
Lymphocytes/mm^3	2 275 (25%)	1 050 (14%)	3 388 (28%)
Monocytes/mm^3	91 (1%)	750 (10%)	242 (2%)
Eosinophils/mm^3	364 (4%)	0 (0%)	0 (0%)
Mean cell volume (mm^3)	66	68	70
Mean cell haemoglobin concentration (%)	33.9	33.8	34.0
Urea nitrogen (mg/100 ml)	10	10	20
Phosphorus (mg/100 ml)	5.52	6.80	7.85
Alkaline phosphatase (King Armstrong units)	14.1	10.53	31.4
Serum glutamic phosphoric transaminase (Reitman Frankel units)	38	33	110
Total protein (g/100 ml)	6.80	6.75	5.50
Albumin (g/100 ml)	3.80	3.70	3.60
Globulin (g/100 ml)	3.00	3.05	1.90
Albumin/Globulin ratio	1.26	1.21	1.89

Figures in parentheses are the relative distribution of leucocytes. All biochemistry results are within normal values, except for alkaline phosphatase and serum glutamic phosphoric transaminase (Day 13) which are increased above the normal values.

condition was reported.

Ehrlichiosis with Babesiosis

Dogs in which simultaneous infections of *E. canis* and *B. canis* occurred, usually showed signs which were typical of canine babesiosis. These signs consisted of pyrexia, depression and lethargy, pallor of mucous membranes, splenomegaly, vomiting, anorexia and accelerated pulse rate. Haemorrhagic signs were only seen occasionally. Typical examples of cases seen were Case 14910 and Case 18594.

Case 14910 was a four year old male, cross-bred dog which was brought to the clinic because it had been anorexic for three days and was reported to have lost weight over the last two to three weeks.

Physical examination of the dog revealed a rectal temperature of 39°C, pale mucous membranes, a poor volume pulse and splenomegaly. Stained peripheral blood smears contained *B. canis* and the cell culture test was positive for *E. canis*.

The dog was treated immediately with a single subcutaneous injection of 5% phenamidine isethionate solution [C] and oral tetracycline hydrochloride for 14 consecutive days. The dog was reported to be eating normally two days later. Follow up blood analysis (Table 4) showed a gradual improvement in the packed

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[C] Phenamidine solution - May and Baker Ltd., Dagenham England

TABLE 4

EHRLICHIOSIS WITH BABESIOSIS

CLINICAL HAEMATOLOGY AND SERUM BIOCHEMISTRY OF CASE 14910

PARAMETER	DAY 0	DAY 1	DAY 3	DAY 7
Packed cell volume (%)	17	13	15	21
Haemoglobin (g/100 ml)	5.6	4.2	4.9	6.9
Erythrocytes X $10^6/mm^3$	2.28	1.30	1.95	2.78
Nucleated erythrocytes (%)	3		0	0
Platelets X $10^3/mm^3$	-	-	-	-
Leucocytes/mm^3	17 900	18 400	22 400	10 800
Neutrophils/mm^3	8 771 (49%)	9 016 (49%)	10 752 (48%)	5 076 (47%)
Lymphocytes/mm^3	7 160 (40%)	8 648 (47%)	10 080 (45%)	2 916 (27%)
Monocytes/mm^3	1 074 (6%)	552 (3%)	1 120 (5%)	216 (2%)
Eosinophils/mm^3	895 (5%)	184 (1%)	448 (2%)	2 484 (23%)
Mean cell volume (mm^3)	74	76	78	74
Mean cell haemoglobin concentration (%)	33.0	32.3	33.0	32.9
Urea nitrogen (mg/100 ml)	25	-	10	20
Phosphorus (mg/100 ml)	-	-	5.68	7.25
Alkaline phosphatase (King Armstrong units)	-	-	13.6	16.2
Serum glutamic phosphoric transaminase (Reitman Frankel units)	-	-	40	2
Total protein (g/100 ml)	9.60	-	9.10	8.80
Albumin (g/100 ml)	3.40	-	3.10	1.90
Globulin (g/100 ml)	5.20	-	6.00	6.90
Albumin/Globulin ratio	0.65	-	0.52	0.28

Figures in parentheses are the relative distribution of leucocytes. All biochemistry parameters are within normal values.

cell volume and an increase in the absolute eosinophil count.

Case 18594 was a two year old, male German Shepherd dog which had suffered a single but prolonged episode of epistaxis four days prior to presentation at the clinic. On examination of the dog, profuse epistaxis, excessive salivation, splenomegaly and hind leg weakness was found. Body temperature was raised (41°C), pulse was rapid (140 per minute) and of poor volume, pallor was pronounced and there were petechial haemorrhages visible on the mucous membranes of the gums. A Giemsa - stained peripheral blood smear was found to be positive for *B. canis* and the cell culture test was positive for *E. canis*. Blood parameters are given in Table 5.

The dog was treated immediately with 5% phenamidine isethionate solution and tetracycline hydrochloride for 14 consecutive days. Fourteen days later, the dog was again examined at the clinic, by which time he showed marked improvement although some pallor of the mucous membranes persisted. The cell culture test was still positive for *E. canis* on the last day of the tetracycline therapy.

Ehrlichiosis with Uraemia

The range of signs shown in uraemic cases included polyuria, polydipsia, depression, anorexia, vomiting, pale or congested mucous membranes, oedema of limbs, halitosis and oral ulceration. Serum analysis indicated increased blood urea nitrogen and inorganic phosphorus levels. If the treatment was initiated early,

TABLE 5

EHRLICHIOSIS WITH BABESIOSIS

CLINICAL HAEMATOLOGY AND SERUM BIOCHEMISTRY OF CASE 18594

PARAMETERS	DAY 0
Packed cell volume (%)	20
Haemoglobin (g/100 ml)	6.8
Erythrocytes X $10^6/mm^3$	3.8
Nucleated erythrocytes (%)	-
Platelets X $10^3/mm^3$	Below normal
Leucocytes/mm^3	16 200
Neutrophils/mm^3	11 938 (74%)
Lymphocytes/mm^3	3 564 (22%)
Monocytes/mm^3	324 (2%)
Eosinophils/mm^3	324 (2%)
Mean cell volume (mm^3)	59
Mean cell haemoglobin concentration (%)	34
Urea nitrogen (mg/100 ml)	15
Phosphorus (mg/100 ml)	7.2
Alkaline phosphatase (King Armstrong units)	12.2
Serum glutamic phosphoric transaminase (Reitman Frankel units)	93
Total protein (g/100 ml)	5.65
Albumin (g/100 ml)	1.65
Globulin (g/100 ml)	4.00
Albumin/Globulin ratio	0.42

Figures in parentheses are the relative distribution of leucocytes.
All biochemical parameters are within normal values, except for serum glutamic phosphoric transaminase which is increased by 50%.

these dogs responded well to oral tetracycline hydrochloride and fluids, and could be maintained on a low protein diet. Some dogs in the advanced stages of renal failure vomited after the tetracycline hydrochloride, particularly when given at the recommended dose level of 66 mg per kg per day, for 14 consecutive days. They would begin to reject the tetracycline hydrochloride capsules after five to seven days of the above treatment. These dogs were better able to tolerate doxycycline[d] at 10 mg per kg per day, for 14 consecutive days. With treatment, the blood urea nitrogen and inorganic phosphorus levels usually decreased to within normal levels. Dogs with irreversible kidney damage continued to have high blood urea nitrogen levels but they could be maintained for a period of time on a low protein diet.

Case 18573 is a clinical case of ehrlichiosis with uraemia.

Case 18573 was a five year old male, Bull Terrier with a history of anorexia for three days. The body temperature was 37.5°C. There was splenomegaly, pallor of mucous membranes and a poor volume pulse rate of 120 per minute, which was tapping in quality. There was no history of vomiting but halitosis and oral ulcers were present. There was also bleeding from the gum margins. Giemsa - stained peripheral blood smears were positive for *B. canis*. The cell culture test was positive for *E. canis*. The dog was treated immediately with 5% phenamidine isethionate solution, oral tetracycline hydrochloride for 14 consecutive

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[d]Vibramycin - Pfizer Laboratories Ltd., New York, USA.

days and intravenous isotonic fluids. Blood parameters were monitored periodically during hospitalisation (Table 6). When an improvement in the blood urea nitrogen was evident and the dog was eating again, it was discharged from the clinic, with instructions to feed a special low protein diet.

Ehrlichiosis Causing Breeding Abnormalities

Abnormalities of the reproductive system such as inability to conceive, abortions, blood clots in prooestrus and prolonged bleeding during oestrus cycle were also suspected to be due to *E. canis*. Nine such cases were seen in this study (Table 1). Bitches in this group harboured the organism and usually responded to treatment. A few bitches which did not come into season during their first or second year of age, came into oestrus soon after treatment for canine ehrlichiosis; bitches which had failed to conceive to repeated service became pregnant following treatment. Case 12008 is a clinical case of canine ehrlichiosis with oestral abnormalities.

Case 12008 was a six year old female Great Dane which was presented to the clinic because of irregular bleeding during her oestrus cycle, during which she passed large clots of blood. Although her appetite was good, she had been losing weight. The cell culture test was positive for *E. canis*. She was treated with tetracycline hydrochloride at 50 mg per kg per day, for 14 consecutive days.

Sixteen days later, she was found to have lost a further

TABLE 3

EHRLICHIOSIS WITH UREMIA

CLINICAL HAEMATOLOGY AND SERUM BIOCHEMISTRY OF CASE 18573

PARAMETER	DAY 0	DAY 1	DAY 2	DAY 10	DAY 13	DAY 15
Packed cell volume (%)	17	20	27	31	28	31
Haemoglobin (g/100 ml)	5.6	6.9	8.7	10.8	9.4	10.0
Erythrocytes X 10^6/mm^3	2.60	3.15	3.60	4.35	4.01	4.42
Nucleated erythrocytes (%)	4	2	1	0	0	0
Platelets X 10^3/mm^3	Normal	Normal	Normal	Normal	Normal	Normal
Leucocytes/mm^3	7 600	13 400	9 000	4 700	5 100	4 300
Neutrophils/mm^3	5 092	9 380	7 200	3 807	2 961	2 924
Lymphocytes /mm^3	2 508	3 886	1 710	799	1 877	1 075
Monocytes /mm^3	0	0	0	0	0	0
Eosinophils/mm^3	0	134	0	94	63	258
Mean cell volume (μ^3)	73	69	73	79	71	72
Mean cell haemoglobin concentration (%)	33.0	33.0	32.4	35.0	33.5	32.5
Urea nitrogen (mg/100 ml	125	140	98	75	75	65
Phosphorus (mg/100 ml)	13.0	12.4	16.2	16.4	-	7.2
Alkaline phosphatase (King Armstrong units)	7.9	5.9	-	7.1	-	10.0
Serum glutamic phosphoric transaminase (Reitman Frankel units)	55	53	66	71	-	46
Total protein (g/100 ml)	6.90	7.20	7.75	6.25	6.00	5.25
Albumin (g/100 ml)	2.65	2.75	2.90	2.50	2.50	2.60
Globulin (g/100 ml)	4.25	4.45	4.85	3.75	3.50	2.65
Albumin/Globulin ratio	0.63	0.62	0.60	0.67	0.71	0.98

All biochemical parameters are within normal values except for urea nitrogen and serum glutamic phosphoric transaminase (Days 2 & 10) which is increased by 10%.

2.6 kg . The oestrus cycle was over and the dog was no longer bleeding. The cell culture test was still positive for *E. canis*. Blood parameters are given in Table 7. The dog was treated with a single intramuscular injection of imidocarb dipropionate[e] at 5 mg per kg body weight. There were no adverse effects on administration of the drug. Three weeks later, the dog had gained 2.3 kg and was very well in herself and a second injection of imidocarb dipropionate was administered. Two weeks later the dog was found to have gained a further 1 kg in weight. Subsequently she showed a normal oestral cycle.

Subclinical Ehrlichiosis

Dogs with subclinical disease were those dogs in which there was evidence that some form of stress or concomittant disease was associated with the appearance of overt clinical signs of ehrlichiosis. Stress factors such as major surgery, malnutrition or pregnancy, and concomittant diseases such as babesiosis, liver disease, distemper, extensive neoplasia, *Dirofilaria immitus* infection or helminthiasis were observed to precipitate clinical ehrlichiosis. If *B. canis* infection was diagnosed and treated while the ehrlichiosis remained untreated, the dog would respond to treatment initially, but recovery would be considerably slower than if both diseases were treated simultaneously or if babesiosis was the only disease present.

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[e] Imizol - The Wellcome Foundation, London, England.

TABLE 7

EHRLICHIOSIS CAUSING BREEDING ABNORMALITIES

CLINICAL HAEMATOLOGY AND SERUM BIOCHEMISTRY OF CASE 12008

PARAMETER	DAY 0	DAY 16	DAY 42
Packed cell volume (%)	47	44	44
Haemoglobin (g/100 ml)	16.6	15.4	16.0
Erythrocytes X $10^6/mm^3$	7.31	6.72	6.85
Nucleated erythrocytes (%)	-	-	-
Platelets X $10^3/mm^3$	Normal	-	-
Leucocytes/mm^3	13 300	15 300	10 700
Neutrophils/mm^3	9 975 (75%)	10 251 (67%)	5 671 (53%)
Lymphocytes/mm^3	2 660 (20%)	3 519 (23%)	2 782 (26%)
Monocytes/mm^3	0 (0)	306 (2%)	0 (0)
Eosinophils/mm^3	665 (5%)	1 224 (8%)	2 247 (21%)
Mean cell volume (um^3)	66	65	65
Mean cell haemoglobin concentration (%)	34.6	35.0	36.0
Urea nitrogen (mg/100 ml)	-	15	25
Phosphorus (mg/100 ml)	-	-	-
Alkaline phosphatase (King Armstrong units)	-	-	-
Serum glutamic phosphoric transaminase (Reitman Frankel units)	-	-	-
Total protein (g/100 ml)		-	7.50
Albumin (g/100 ml)	-	-	3.40
Globulin (g/100 ml)	-	-	4.10
Albumin/Globulin ratio	-	-	0.83
Ehrlichia canis	+	+	

Figures in parentheses are the relative distribution of leucocytes. All biochemical parameters are within normal values.

Where ehrlichiosis remained untreated, in dual infections, some dogs suffered acute ehrlichiosis a week or so later, or weeks to months later, dogs were likely to be presented either with acute ehrlichiosis or with weight loss and the development of a selective appetite. The term selective appetite was used to describe the situation where the dog did not eat all its food every day, or ate one day but not the next, or merely picked at the tasty morsels in its food whilst previously it had been in the habit of eating everything it was given. It was difficult or impossible to find morulae of *E. canis* in peripheral blood films from these cases but the organism could be identified by the cell culture test. This form of ehrlichiosis was classified as subclinical disease.

The healthy carrier state of ehrlichiosis was distinguished from subclinical disease because when dogs in the carrier state were stressed, they did not develop clinical disease. In the healthy carrier state, *E. canis* was never found on peripheral blood smear examination, however, *E. canis* could be readily identified by the cell culture test. Seventy-one working dogs, such as those in the police and armed forces were found to harbour *E. canis* by the cell culture test. However, these dogs did not develop clinical signs even though they were exercised or worked strenuously. When the results of the haematological and serum biochemical analysis on blood from these 71 dogs, which were positive for *E. canis*, were compared with 20 dogs which were negative for *E. canis*, the student *t* test showed that there was

no significant difference between these two groups of dogs as far as their packed cell volume, haemoglobin, leucocyte count, neutrophil count, lymphocyte count, monocyte count, eosinophil count, basophil count, inorganic phosphorus, total protein, albumin, globulin and albumin/globulin ratio were concerned. A marginally significant difference in the blood urea nitrogen estimations was noted at the 5% level (Table 8).

Chronic Ehrlichiosis

Chronic ehrlichiosis was diagnosed in four cases. The dogs either showed repeated haemorrhage until death or slowly deteriorated until death, with the exception of Case 16049. The haemorrhage was either in the form of epistaxis, haemorrhage into body cavities and/or subcutaneously. One dog died as a result of splenic rupture. All dogs in this group were anaemic, leucopenic and thrombocytopenic. One such example is Case 19002. Hypoplasia of the bone marrow was evident on examination of bone marrow smears in two cases. The cases were efractory to any type of treatment with the exception of Case 16049 which is documented in detail.

Case 19002 was a two year old male, Irish Setter which had a history of depression, petechial and ecchymotic haemorrhages on the gums and abdomen but was not pyrexic. The dog was treated with a babecidal drug and tetracycline hydrochloride and then showed a rise in body temperature. The dog did not improve clinically. Five weeks later, the dog was depressed and pyrexic and it was referred to the clinic.

TABLE 8

HAEMATOLOGICAL AND BIOCHEMICAL FINDINGS
FROM ASYMPTOMATIC *EHRLICHIA* POSITIVE AND NEGATIVE DOGS

PARAMETER	SAMPLE NUMBER		SAMPLE MEAN ± S.E.		t_{VALUE}	P
	Positive	Negative	Positive	Negative		
Packed cell volume (%)	71	20	49.27 ±0.67	50.35 ±1.17	$t_{89} = 0.77$	N.S.
Haemoglobin (g/100 ml)	71	20	17.20 ±0.23	17.51 ±0.43	$t_{89} = 0.63$	N.S.
Leucocytes/mm^3	71	20	12.00 ±0.48	10.37 ±0.58	$t_{89} = 1.71$	N.S.
Neutrophils/mm^3	71	20	7.25 ±0.32	6.54 ±0.49	$t_{89} = 1.09$	N.S.
Lymphocytes/mm^3	71	20	3.37 ±0.20	2.70 ±0.17	$t_{89} = 1.72$	N.S.
Monocytes/mm^3	71	20	0.08 ±0.02	0.03 ±0.02	$t_{89} = 1.09$	N.S.
Eosinophils/mm^3	71	20	1.23 ±0.12	1.11 ±0.21	$t_{89} = 0.48$	N.S.
Basophils/mm^3	71	20	0.03 ±0.01	0.01 ±0.01	$t_{89} = 1.24$	N.S.
Urea nitrogen (mg/100 ml)	21	18	27.43 ±1.70	22.11 ±1.81	$t_{37} = 2.14$	<0.05
Phosphorus (mg/100 ml)	8	10	5.30 ±0.71	4.90 ±0.20	$t_{16} = 0.60$	N.S.
Total protein (g/100 ml)	14	16	6.29 ±0.21	6.16 ±0.22	$t_{28} = 0.42$	N.S.
Albumin (g/100 ml)	13	16	3.59 ±0.15	3.82 ±0.31	$t_{27} = 0.63$	N.S.
Globulin (g/100 ml)	13	16	2.68 ±0.18	2.33 ±0.20	$t_{27} = 1.26$	N.S.
Albumin/Globulin ratio	13	16	1.41 ±0.12	1.83 ±0.17	$t_{27} = 1.91$	N.S.

N.S. = Not significant at the 5% level.

On admission the dog had a normal body temperature, normal appetite but the mucous membranes were pale. It had developed an abscess on its neck at the site of a previous injection. The cell culture test was positive for *E. canis*. The abscess was lanced and the dog treated with oral tetracycline hydrochloride at 66 mg per kg, per day, for 14 consecutive days. At this stage the packed cell volume was only 19%, the leucocyte count was 4 800 per cu mm and the thrombocyte count was below the normal level of 200 000 per cu mm (Table 9). Two days later, the leucocyte count was found to be only 2 200 per cu mm. The dog was treated with intravenous ethoxyethylglyoxal dithiosemicarbazone[f] at 10 mg per kg. Treatment with tetracycline hydrochloride was continued. Although the dog was still pancytopenic on Day 6, it was sent home.

On Day 14, the dog was returned to the clinic because although it was lively at times and ate well, it still slept a lot and was not gaining weight. Body temperature was normal (38.6°C), mucous membranes were very pale, pulse rate was 120 per minute and no abnormalities were detected on palpation of the abdomen. A peripheral blood smear was negative for blood parasites and there were no signs of regeneration of erythrocytes on the smear. The following day, the dog was treated with

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[f]Gloxazone - Burroughs Wellcome and Co., London, England.

TABLE 9

CHRONIC EHRLICHIOSIS

CLINICAL HAEMATOLOGY AND SERUM BIOCHEMISTRY OF CASE 19002

PARAMETER	DAY 0	DAY 2	DAY 5	DAY 6	DAY 13	DAY 14	DAY 16	DAY 20	DAY 21	DAY 22
Packed cell volume	19	19	20	20	15	14	17	13	14	12
Haemoglobin (g/100 ml)	6.0	6.7	6.2	6.8	5.1	4.8	5.6	4.7	4.8	3.4
Erythrocytes X $10^6/mm^3$	2.23	2.51	2.26	2.39	1.82	1.83	2.27	1.75	1.49	1.25
Nucleated erythrocytes (%)	-	-	-	-	-	-	-	-	-	-
Platelets X $10^3/mm^3$	<Normal	<Normal	34	41	38	41	37	21	25	31
Leucocytes/mm^3	4 800	2 200	2 300	2 100	2 000	2 200	2 200	2 000	2 200	2 600
Neutrophils/mm^3	3 840	-	-	-	1 [illegible]60	-	-	-	-	-
Lymphocytes/mm^3	960	-	-	-	1 140	-	-	-	-	-
Monocytes/mm^3	-	-	-	-	[illegible]	-	-	-	-	-
Eosinophils/mm^3	-	-	-	-	-	-	-	-	-	-
Mean cell volume/μm^3	86	83	87	86	83	83	87	84	89	90
Mean cell haemoglobin concentration (%)	32.0	35.4	31.0	34.0	34.0	34.3	34.0	36.2	34.2	28.4
Urea nitrogen (mg/100 ml)	15	10	10	10	20	-	--	-	35	-
Phosphorus (mg/100 ml)	-	-	-	-	-	-	-	-	-	-
Alkaline phosphatase (King Armstrong units)	-	-	-	-	6.30	-	-	-	7.20	-
Serum glutamic phosphoric transaminase (Reitman Frankel units)	-	-	-	-	13.0	-	-	-	9.0	-
Total protein (g/100 ml)	7.10	7.40	6.90	-	6.25	-	-	-	6.35	-
Albumin (g/100 ml)	3.10	3.45	3.40	-	3.10	-	-	-	2.90	-
Globulin (g/100 ml)	4.00	3.95	3.50	-	3.15	-	-	-	3.45	-
Albumin/Globulin ratio	0.78	0.78	0.97	-	0.98	-	-	-	0.84	-

All biochemical parameters are within normal values.

1 mg per kg of anabolic steroid [g], 7 mg per kg of imidocarb dipropionate and a combination of B vitamins, all given by intramuscular injection. The dog's state of health continued to deteriorate, although the appetite was normal. Two days later, the dog collapsed and was destroyed. A bone marrow biopsy, taken just prior to death, was hypoplastic.

On post mortem examination of the dog, it was found to be in moderate physical condition. Several ticks were found on different parts of the carcase. An abscess was present dorsally in the neck. The subcutaneous tissue was very pale, prescapular lymph nodes were enlarged, wet and dark red in colour. The liver and kidneys were pale and friable. The spleen was normal in size. The lungs were not properly collapsed. The heart showed a rounded apex due to left sided dilatation; the mitral valves were nodular and thickened; changes usually associated with endocardosis. The bone marrow was very pale and watery.

Histologically the lymph nodes revealed active follicles but had extensive haemorrhages in the sinus spaces with erythrophagocytosis and accumulation of large numbers of plasma cells. There were extensive haemorrhages in the zona fasciculata of the adrenal gland. There was no myocardial changes although the wall of the arteries were swollen and oedematous. There were haemorrhages in the pons and the

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[g]Deca-durabolin (Nandrolone Decanoate) - Organon Laboratories Ltd., Surrey, England.

cerebral cortex of the brain.

Case 16049, a six year old female, German Shepherd dog was referred to the clinic with a history of losing condition over two weeks and epistaxis two days prior to referral at which time she had babesiosis and had been treated with vitamin K and 5% phenamidine isethionate solution. The epistaxis had reoccurred the next day.

Although this case was seen before the start of this 20 month study period, it was included in this study because it was very interesting. Dates have been used since it was seen frequently and over a long period of time.

24 May 1976: On physical examination, the bitch was in poor condition (body weight was 26.8 kg) but was eating well. Body temperature was 39.5°C. The mucous membranes were pale and there was halitosis and epistaxis. The palpable lymph nodes were not enlarged but splenomegaly was present. The bitch was reported to be drinking excessively. The cell culture test was positive for *E. canis*. The packed cell volume was 23% at this stage, but three days later it had dropped to only 18% and leucopenia was evident (4 200 per cu mm) (Table 10). The bitch was treated with tetracycline hydrochloride at 37 mg per kg, per day, for 14 consecutive days.

12 June 1976: the bitch was presented at the clinic because it was not well and was anorexic. Body temperature was not elevated and pulse was within normal range. Splenomegaly was

TABLE 10

CHRONIC EHRLICHIOSIS

CLINICAL HAEMATOLOGY AND SERUM BIOCHEMISTRY OF CASE 16049

PARAMETER	24/5/76	25/5/76	27/5/76	2/6/76	12/6/76	15/6/76
Packed cell volume (%)	23	23	18	28	23	26
Haemoglobin (g/100 ml)	7.9	7.7	5.9	9.8	7.5	9.4
Erythrocytes X $10^6/mm^3$	2.16	2.09	2.93	3.68	3.34	3.48
Nucleated erythrocytes (%)	-	-	-	-	-	-
Platelets/mm^3	-	-	Normal	Normal	92 000	-
Leucocytes/mm^3	8 100	7 300	4 200	6 400	4 700	5 000
Neutrophils/mm^3	4 941	3 796	3 024	3 712	3 008	3 500
Lymphocytes/mm^3	2 511	3 066	840	2 368	1 222	800
Monocytes/mm^3	648	0	294	64	141	150
Eosinophils/mm^3	0	438	42	256	329	550
Basophils/mm^3	0	0	0	0	0	0
Mean cell volume (μm^3)	78	70	68	68	75	71
Mean cell haemoglobin concentration (%)	34.3	33.1	32.8	34.6	32.6	36.1
Urea nitrogen (mg/100 ml)	30	25	30	28	16	30
Phosphorus (mg/100 ml)	8.0	6.3	7.5	7.2	5.7	4.9
Alkaline phosphatase (King Armstrong units)	5.0	5.5	5.0	3.3	10.5	5.8
Serum glutamic phosphoric transaminase (Reitman Frankel units)	7.0	10.0	4.0	17.0	28.0	10.0
Total protein (g/100 ml)	7.80	8.75	8.70	5.50	9.10	8.50
Albumin (g/100 ml)	1.60	1.60	1.90	2.25	1.70	1.50
Globulin (g/100 ml)	6.20	7.15	6.80	3.25	7.40	7.00
Albumin/Globulin ratio	0.25	0.22	0.27	0.69	0.22	0.21

PARAMETER	17/6/76
Packed cell volume (%)	27
Haemoglobin (g/100 ml)	9.0
Erythrocytes X $10^6/mm^3$	3.55
Nucleated erythrocytes (%)	-
Platelets/mm^3	Normal
Leucocytes/mm^3	4 500
Neutrophils/mm^3	2 835
Lymphocytes/mm^3	1 260
Monocytes/mm^3	0
Eosinophils/mm^3	405
Basophils/mm^3	0
Mean cell volume (μm^3)	68
Mean cell haemoglobin concentration (%)	33.4
Urea nitrogen (mg/100 ml)	-
Phosphorus (mg/100 ml)	-
Alkaline phosphatase (King Armstrong units)	-
Serum glutamic phosphoric transaminase (Reitman Frankel units)	-
Total protein (g/100 ml)	-
Albumin (g/100 ml)	-
Globulin (g/100 ml)	-
Albumin/Globulin ratio	-

TABLE 10 (continued)

18/6/76	24/6/76	29/6/76	8/7/76	22/7/76
27	31	26	31	33
8.6	9.9	8.5	10.4	12.0
3.55	3.90	3.70	5.15	6.00
-	-	-	-	-
Normal	<Normal	214 000	208 000	Normal
1 900	4 900	8 500	6 300	6 000
2 730	3 479	5 865	4 473	3 300
819	784	2 295	1 197	1 620
0	294	85	63	0
351	343	255	567	1 080
0	0	0	0	0
70	71	70	66	67
31.8	31.9	33.0	33.5	30.2
22	30	20	30	-
5.3	5.5	-	6.7	-
2.5	3.1	-	3.8	-
5.0	5.0	-	5.0	-
10.80	7.45	-	9.72	-
1.50	2.38	-	1.95	-
9.30	5.07	-	7.77	-
0.16	0.46	-	0.25	-

PARAMETER	8/9/76	28/6/77
Packed cell volume (%)	33	42
Haemoglobin (g/100 ml)	11.7	14.7
Erythrocytes X $10^6/mm^3$	4.87	5.95
Nucleated erythrocytes (%)	-	-
Platelets/mm^3	Normal	235 000
Leucocytes/mm^3	7 200	9 200
Neutrophils/mm^3	3 960	4 876
Lymphocytes/mm^3	2 736	3 128
Monocytes/mm^3	72	0
Eosinophils/mm^3	432	276
Basophils/mm^3	0	0
Mean cell volume (μm^3)	66	68
Mean cell haemoglobin concentration (%)	35.4	35.0
Urea nitrogen (mg/100 ml)	27	25
Phosphorus (mg/100 ml)	4.2	3.9
Alkaline phosphatase (King Armstrong units)	11.9	9.2
Serum glutamic phosphoric transaminase (Reitman Frankel units)	12.0	12.0
Total protein (g/100 ml)	8.25	6.90
Albumin (g/100 ml)	2.50	2.40
Globulin (g/100 ml)	5.75	4.50
Albumin/Globulin ratio	0.43	0.54

TABLE 10 (Continued)

7/2/78	10/3/78	12/5/78	6/6/78	14/12/78
33	38	40	44	38
11.1	13.0	13.9	15.7	13.1
4.56	5.24	5.35	6.26	5.37
-	-	-	-	-
389 000	410 000	183 000	183 000	278 000
5 400	8 100	7 600	6 400	4 700
2 460	4 779	5 700	3 840	2 820
2 592	2 349	1 216	1 856	1 410
0	81	0	0	47
162	891	684	512	376
0	0	0	64	47
69	71	72	75	79
33.4	34.2	35.0	36.0	34.6
25	10	30	-	22
-	-	5.8	-	4.9
-	-	5.3	-	5.0
-	-	3.0	-	-
9.10	8.10	8.60	-	8.60
1.85	3.10	3.60	-	2.60
7.25	5.00	5.00	-	6.00
0.30	0.60	0.72	-	0.43

present. Body weight was 29 kg. Blood was taken for analysis and culture and treatment was deferred until the results were known. An episode of epistaxis occurred half an hour after the bitch went home. The blood analysis revealed that the bitch was anaemic (packed cell volume was 23%), leucopenic (4 500 per cu mm) and thrombocytopenic (92 000 per cu mm).

14 June 1976: on physical examination, the bitch was very weak, the mucous membranes were pale and there was a poor volume pulse with a rate of 120 per minute. Splenomegaly was still present and the bitch had evenly distributed harsh lung sounds on auscultation. Blood for the cell culture test was found to be highly positive for *E. canis*. The bitch was again treated with oral tetracycline hydrochloride but at a higher dosage (53 mg per kg, per day, for 14 days), and by an intravenous injection of ethoxyethylglyoxal dithiosemicarbazone at 10 mg per kg. Ten days later the bitch was reported to be bright and gaining weight. The packed cell volume had increased to 31% but she was still leucopenic (4 900 per cu mm) and thrombocytopenic.

29 June 1976: the bitch was again presented to the clinic with epistaxis and a selective appetite. The bitch was given a general anaesthetic, using intravenous thiopentone and maintained on halothane. A bone marrow biopsy was performed and the marrow found to be hypoplastic. The bitch was again treated with intravenous ethoxyethylglyoxal dithiosemicarbazone

at 10 mg per kg. Tetracycline hydrochloride was also administered at 53 mg per kg, per day, for 14 days. No adverse effects were seen after this drug.

8 September 1976: nine weeks after the above treatment, the bitch had gained 4 kg in weight. She was reported to have a good appetite and was bright. Body temperature was 38.3°C. The mucous membranes were pink and pulse volume was good. Splenomegaly was still present and although blood collected for the cell culture test was still positive for *E. canis*, the bitch was not treated. Packed cell volume was 33%, leucocyte count was 7 200 per cu mm and thrombocytes were normal in number.

28 June 1977: for the last nine months the bitch had been very fit, but recently had developed a selective appetite. Body weight had remained at 32.5 kg. Mucous membranes were slightly pale and pulse volume was poor. No further epistaxis was reported but blood collected for cell culture was still positive for *E. canis*. The bitch was treated again with daily tetracycline hydrochloride at 62 mg per kg, for 14 days. When examined a month later, she was doing well. Packed cell volume was 42%, leucocyte count was 9 200 per cu mm and thrombocytes were within the normal range (235 000 per cu mm).

7 February 1978: seven months later weight loss was again evident (4.5 kg weight loss). The mucous membranes were pale, and the spleen enlarged, but no other abnormality was detected on physical examination. Blood for the cell culture test was

positive for *E. canis*. Packed cell volume was 33%, leucocyte count was 5 400 and platelet count was within the normal level. The bitch was treated with tetracycline hydrochloride at 66 mg per kg, for 14 days. Ten days later, slight weight gain was noted (1 kg).

10 March 1978: 23 days later the bitch was returned to the clinic because she had failed to gain more weight. The tetracycline hydrochloride was repeated for the sixth time and then she only gained 1 kg in 8 weeks.

26 May 1978: the bitch had again developed a selective appetite and was returned to the clinic. Body temperature was 37.6°C. Peripheral blood smears were negative for blood parasites. This time she was treated with oral chloramphenicol at 50 mg per kg, per day, for 10 days. At the end of the ten days, the bitch had gained weight (body weight was 31.8 kg). However, since the cell culture test was highly positive for *E. canis*, she was put back on to tetracycline hydrochloride for 14 days.

14 September 1978: three months later, the bitch had again lost weight (4 kg). She had a poor hair coat and the mucous membranes were pale. She was treated with chloramphenicol at 55 mg per kg, per day, for 14 days.

11 December 1978: the bitch was reported to have killed two lambs for no apparent reason and the owner requested that the bitch be put down. Blood taken for the cell culture test

was negative for *E. canis*.

On post mortem examination, the carcase was emaciated. Both kidneys were pale and the capsule was slightly adherent to the cortical surface. Histologically, the kidneys showed marked destruction of glomeruli. Many capsular spaces were either empty or filled with a pink-staining mass. The remaining glomeruli were contracted. Pink-staining hyaline casts were present in many tubules. There were many scattered foci of mononuclear cell infiltration.

Grossly the liver was normal; however, histologically, there was moderate congestion and slight cytoplasmic vacuolisation. Grossly, the spleen, lungs and heart were also normal.

There were a few shallow aneurysms in the aorta which were characteristic of *Spirocerca lupi* infection. The brain showed moderate hydrocephalus of the lateral ventricles. Histologically the brain was normal except for one area in which there were small haemorrhages. The bone marrow had many mature neutrophils.

The age incidence of dogs presented to the clinic with ehrlichiosis is given in Table 11. There was no significant difference between the pure-bred dogs, the German Shepherd dogs and the cross-bred dogs. The sex incidence of ehrlichiosis was 1.2:1 for males:females, which is the general sex incidence of dogs presented to the clinic.

TABLE 11

AGE INCIDENCE OF CANINE EHRLICHIOSIS IN NATURALLY OCCURRING CLINICAL CASES

AGE	GERMAN SHEPHERD DOGS	PURE-BRED DOGS	CROSS-BRED DOGS
< 3 Months	1	0	0
3 - 6 Months	6	4	2
6 - 11 Months	14	11	10
1 Year	13	14	14
2 Years	12	24	18
3 Years	19	15	6
4 Years	12	15	6
5 Years	9	14	3
6 Years	7	21	5
7 Years	5	8	5
8 Years	1	14	6
9 - 14 Years	7	15	4

The age incidence of naturally occurring canine ehrlichiosis closely follows the age incidence of dogs presented to the small animal clinic. Very young dogs and very old dogs are seldom seen in the clinic.

The most commonly found tick on dogs in the Nairobi area was *H. leachii*, but *R sanguineus* was also present. However, a survey was not carried out to establish the occurrence of these two species of ticks on dogs with *E. canis* infection.

Blood Mononuclear Cell Culture Test

A high incidence of clinical disease was found in which *E. canis* could be cultured by the cell culture test. The presence of bacteria, trypanosomes or microfilariae in the Leighton tubes interfered with the test. Either movements of these organisms or pathophysiological changes caused by these infections may have prevented mononuclear cells from settling on the coverslip.

The cell culture test was used to examine blood from dogs within 24 hours of importation into Kenya from non-*Ehrlichia* endemic countries. These were found to be negative for *E. canis*. A false positive result did not arise.

Peripheral Blood Smears

Occasionally in the acute stage of the disease, Giemsa - stained peripheral blood smears revealed the presence of *E. canis* organisms in the mononuclear cells. Care was taken to distinguish between azurophilic granules and initial bodies or morulae in the cytoplasm of mononuclear cells, the latter being enclosed in a definite membrane within the cytoplasm.

Haematological and Serum Biochemical Analysis

The results of haematological and serum biochemical analysis were compared between 128 pure-bred dogs (excluding German Shepherd dogs), 88 German Shepherd dogs and 72 cross-bred dogs which were clinical cases of ehrlichiosis and harboured *E. canis* (Table 12). The F test showed that there was no significant difference between these three groups of dogs as far as their packed cell volume, leucocyte, neutrophil, lymphocyte, monocyte and eosinophil counts were concerned. There was a significant difference (<0.05) in the haemoglobin, total protein, albumin, globulin and albumin/globulin ratio (Table 12).

When the overall mean of the packed cell volume, leucocyte, lymphocyte, monocyte and eosinophil count of the asymptomatic dogs (Table 8) were compared with the overall mean of the clinical cases (Table 12), the packed cell volume and eosinophil count were found to be significantly different (Table 13).

The least significant difference was calculated in order to discover which of these three groups of *E. canis* positive dogs differed. In the case of total protein, albumin and globulin, there was a significant difference between the pure-bred dogs and the cross-bred dogs. With the albumin/globulin ratios the cross-bred dogs differed significantly from both the pure-bred dogs and the German Shepherd dogs (Table 14). When the Multiple Range test was used on the haemoglobin values for the three groups, the mean for the cross-bred group was significantly

TABLE 12

HAEMATOLOGICAL AND SERUM BIOCHEMICAL FINDINGS FROM DOGS WITH CLINICAL EHRLICHIOSIS

PARAMETER	SAMPLE NUMBER			SAMPLE MEAN ± S.E.			F VALUE	P
	Pure-bred	German Shepherd	Cross-bred	Pure-bred	German Shepherd	Cross-bred		
Packed cell volume (%)	128	88	72	40.67 ± 1.03	42.05 ± 1.11	38.25 ± 1.57	$F^{2}_{285} = 2.08$	N.S.
Haemoglobin (g/100 ml)	127	88	71	14.38 ± 0.28	14.74 ± 0.31	13.15 ± 0.56	$F^{2}_{283} = 4.26$	<0.05
Leucocytes/ mm^3	127	88	71	11.89 ± 0.53	11.56 ± 0.50	12.80 ± 0.98	$F^{2}_{283} = <1$	N.S.
Neutrophils/ mm^3	127	88	70	7.39 ± 0.40	7.14 ± 0.44	8.08 ± 0.82	$F^{2}_{282} = <1$	N.S.
Lymphocytes/ mm^3	127	88	70	3.45 ± 0.20	3.18 ± 0.15	3.55 ± 0.33	$F^{2}_{282} = <1$	N.S.
Monocytes/ mm^3	127	88	70	0.12 ± 0.03	0.14 ± 0.03	0.24 ± 0.13	$F^{2}_{282} = 1.00$	N.S.
Eosinophils/ mm^3	127	88	70	0.78 ± 0.11	0.91 ± 0.09	0.96 ± 0.16	$F^{2}_{282} = <1$	N.S.
Total protein (g/100 ml)	86	55	45	6.51 ± 0.10	6.70 ± 0.16	7.03 ± 0.16	$F^{2}_{183} = 3.70$	<0.05
Albumin (g/100 ml)	83	55	35	3.23 ± 0.07	3.12 ± 0.09	2.89 ± 0.10	$F^{2}_{170} = 3.30$	<0.05
Globulin (g/100 ml)	83	55	35	3.28 ± 0.13	3.56 ± 0.18	3.92 ± 0.20	$F^{2}_{170} = 3.51$	<0.05
Albumin/ Globulin ratio	83	55	35	1.13 ± 0.05	1.09 ± 0.10	0.83 ± 0.08	$F^{2}_{170} = 3.38$	<0.05

TABLE 13

HAEMATOLOGICAL FINDINGS FROM ASYMPTOMATIC DOGS AND DOGS WITH NATURALLY OCCURRING EHRLICHIOSIS

PARAMETER	OVERALL SAMPLE NUMBER		OVERALL SAMPLE MEAN		t VALUE	P
	Asymptomatic	Clinical	Asymptomatic	Clinical		
Packed cell volume (%)	91	288	49.51	40.59	$t_{377}=7.05$	<0.001
Leucocytes/mm^3	91	286	11.64	12.01	$t_{375}=0.53$	N.S.
Neutrophils/mm^3	91	285	7.09	7.48	$t_{374}=0.72$	N.S.
Lymphocytes/mm^3	91	285	3.22	3.39	$t_{374}=0.68$	N.S
Monocytes/mm^3	91	285	0.07	0.16	$t_{374}=1.5$	N.S.
Eosinophils/mm^3	91	285	1.20	0.86	$t_{374}=2.42$	<0.05

KEY: N.S. - Not significant at the 5% level

TABLE 14

A COMPARISON OF SERUM PROTEIN LEVELS AND HAEMOGLOBIN FROM PURE-BRED, GERMAN SHEPHERD AND CROSS-BRED DOGS NATURALLY INFECTED WITH EHRLICHIOSIS

PARAMETER	PURE-BRED DOGS	GERMAN SHEPHERD DOGS	CROSS-BRED DOGS
Total protein (g/100 ml)	6.51	6.70	7.03
Albumin (g/100 ml)	3.23	3.12	2.89
Globulin (g/100 ml)	3.28	3.56	3.92
Albumin/Globulin ratio	1.13	1.09	0.83

PARAMETER	CROSS-BRED DOG	GERMAN SHEPHERD DOG	PURE-BRED DOG
Haemoglobin (g/100 ml)	13.15	14.38	14.74

KEY: The horizontal black lines connect groups that are not significantly different from each other, based on the least significant difference (L.S.D.).

NOTE: However, each of the parameters lie within the normal range for dogs.

lower than either the pure-bred dogs or the German Shepherd dogs. However the mean of the latter two groups did not differ significantly from each other.

DISCUSSION

The incidence of canine ehrlichiosis was high in dogs presented at the clinic, representing 8% of all cases seen. These cases were confirmed by the cell culture test which was more reliable than the presence of morulae on stained peripheral blood smears. In the test described by Nyindo *et al.* (1971), 50 ml of blood were used, whereas this modification required only 10 ml of blood and neither dog serum (Nyindo *et al.*, 1971) nor calf serum (Kaminjolo *et al.*, 1976) were added to these cells during their incubation. Hence this modification enabled the test to be used for small or large dogs and the simple method for incubation and staining of the coverslips resulted in a test that could be carried out in laboratories with limited facilities or under field conditions (Chapter 5). Eosinophilic granules could be mistaken for morulae if care was not taken to distinguish between the two during microscopic examination of the stained mononuclear cultured cells. Other than this, a false positive result could not arise. The test was used on dogs recently imported into Kenya from non-*Ehrlichia* endemic countries. These tests were consistently negative.

Using this test, canine ehrlichiosis was the most frequently diagnosed disease entity at the clinic. Greater awareness of

the different forms of the disease and their presenting clinical signs enabled veterinary surgeons to recognise early and mild clinical cases and prompt treatment resulted in rapid recovery in the majority of cases. Thirty of the 373 cases (8%) in this study did not respond favourably to initial treatment for ehrlichiosis. These cases were either treated with a different drug (see Chapter 4) or some other complication was found. In this study we have assumed that most dogs which were not returned to the clinic after treatment had recovered from the clinical disease. However we are aware that these cases could also either have been taken to another veterinary practice, the original condition ignored by the owner, or that the owner left the country.

During the course of this study, it became recognised that canine ehrlichiosis and canine babesiosis often occurred together. Subsequently, the two diseases tended to be treated simultaneously or follow up arrangements were made whereby the case could be treated for *E. canis* as soon as the culture results were known 48 to 96 hours after initial examination and *Babesia* treatment. In this way, *E. canis* was not left untreated to progress to the chronic stage.

The classical haemorrhagic signs of ehrlichiosis were not commonly seen at the clinic during the past five years. However, when they did occur, they were very dramatic. Since this stage of disease was considered to be an immunopathological phenomenon (Buhles *et al.*, 1974; Scott, 1978), the cases were treated with

steroids and tetracycline hydrochloride. Response to treatment was usually good. Three haemorrhagic cases were refractory to treatment and these were considered to have reached the chronic irreversible stage of disease. The chronic nature of the ehrlichiosis was confirmed in these cases by pancytopenia of peripheral blood and bone marrow hypoplasia. Walker *et al.* (1970) classified the terminal phase of chronic ehrlichiosis as that shown by dogs with epistaxis or dogs with pancytopenia (leucocyte counts of less than 7 500 per cu mm , or packed cell volume of less than 37%, or both). The dogs with pancytopenia had terminal pyrexia and oedema or died suddenly without prior signs except marked weight loss. The dogs with epistaxis either died after acute severe epistaxis or repeated bouts of epistaxis for about three months and petechial and ecchymotic haemorrhages (Walker *et al.*, 1970). The chronic cases of ehrlichiosis seen in this study were similar to those defined by Walker *et al.* (1970).

Ehrlichiosis with central nervous signs also responded to treatment with tetracycline hydrochloride and steroids. This form of disease was considered to be another immunopathological phenomenon, associated with haemorrhages within or around the spinal cord.

More detailed and specialised work would be required to prove that breeding abnormalities are definitely a feature of canine ehrlichiosis. It would be difficult to produce these clinical signs experimentally. However, breeding abnormalities

such as inability to conceive, abortions, blood clots in prooestrus and prolonged bleeding during the oestrus cycle might be studied in large kennels where canine ehrlichiosis was endemic.

Progressive uraemia has often been observed in dogs with long standing ehrlichiosis (Walker *et al.*, 1970; Simpson, 1972a; Immelman and Button, 1973). These findings were confirmed in this study. The kidney damage could be either acute or chronic. Acute kidney damage was more easily treated and reversed; the blood urea nitrogen level returning to within normal levels and the clinical signs regressing after tetracycline hydrochloride therapy. Chronic kidney damage or end stage kidney disease was difficult or impossible to treat successfully. The elevated levels of blood urea nitrogen persisted even after treatment and dogs at this stage could only be maintained on a special low protein diet. Dogs with elevated levels of blood urea nitrogen were often unable to tolerate the high levels of oral tetracycline hydrochloride, but they were better able to tolerate oral doxycycline.

The student *t* test showed that there was no significant difference in the blood parameters of healthy carrier state dogs and those that did not harbour *E. canis*, except for the blood urea nitrogen level. Dogs that harboured *E. canis* had a slightly higher blood urea nitrogen, which is consistent with the findings of Huxsoll *et al.* (1970b), Seamer and Snape (1972), Simpson (1972a) and Immelman and Button (1973). In the clinically ill

dogs, the packed cell volume, leucocyte, neutrophil, lymphocyte, monocyte and eosinophil counts were similar in the pure-bred, cross-bred and German Shepherd dogs, showing that some blood parameters as well as the clinical course of the disease were similar. These findings were different from Huxsoll's (1976) report that the severe chronic form of the disease depended on the breed of the dog. Huxsoll *et al.* (1972) found that most experimentally infected Beagles and cross-bred dogs recovered from the disease but remained infected, while experimentally infected German Shepherd dogs developed a disease syndrome that was indistinguishable from that of the naturally occurring disease.

When the overall mean eosinophil value of the asymptomatic dogs was compared with the overall mean of the clinical cases, the value of the clinically ill dogs was found to be lower than that of the asymptomatic dogs. This is consistent with the findings of Seamer and Snape (1972) and Lawrence and Efstratio (1973) who reported eosinopenia in their study. The globulin level in each of the three groups of clinically ill dogs is also higher than that in the asymptomatic dogs, which is consistent with the findings of Walker *et al.* (1970), Burghen *et al.* (1971), Simpson (1972a), Immelman and Button (1973) and Buhles *et al.* (1974).

This study has shown that there is a high prevalence of canine ehrlichiosis in Kenya with a wide variety of clinical signs. Dogs with subclinical disease and carrier dogs were also

detected. Diagnosis was confirmed by the mononuclear cell culture test which had been modified for use in small as well as large breeds of dogs. An attempt to group these clinical signs has been made and individual clinical cases have been given in detail to illustrate the special features of most of these groups. The clinical cases were also divided according to breeds but there was little significant difference found between pure-bred dogs, German Shepherd dogs and cross-bred dogs.

CHAPTER 3

EXPERIMENTAL CASES OF CANINE EHRLICHIOSIS

Extensive studies have been carried out on dogs subjected to experimental infection with *E. canis*. The interest was stimulated by a severe and widespread outbreak of canine ehrlichiosis in military dogs in Vietnam and Malaysia. Between September 1968 and 1970, approximately 180 American military dogs died of this disease in Vietnam (Huxsoll *et al.*, 1970a).

Soon after the modified cell culture technique was introduced to confirm the diagnosis of *E. canis* in Kenya, it became apparent that the signs of disease in many cases differed considerably from the disease descriptions reported from North America, Europe and Asia. Also the reported differences in reaction of German Shepherd dogs to the infection could not be substantiated by the disease pattern in Kenya.

Walker *et al.* (1970) and Huxsoll *et al.* (1970b, 1972) reported that acute and chronic epistaxis were followed by death. However, Huxsoll (1976) did not associate the severe chronic form of canine ehrlichiosis with strain differences but with differences in the breed of the dog. Huxsoll *et al.* (1972) found that most experimentally infected Beagles and cross-bred dogs recovered from the disease but remained infected, while German Shepherd dogs developed disease that was indistinguishable from the natural disease. The German Shepherd dog often

developed a severe haemorrhagic syndrome 60 or more days after initial infection (Huxsoll, 1975). Haemorrhages were associated with marked thrombocytopenia (Huxsoll *et al.*, 1972).

The classical signs of haemorrhage in canine ehrlichiosis were seen in representatives of most of the dog breeds at the clinic. These signs have been described in Chapter 2.

Since clinical cases of naturally occurring canine ehrlichiosis in Kenya did not appear to conform to the generally accepted disease pattern reported elsewhere, it was decided to infect dogs experimentally and follow the course of the disease in these dogs.

MATERIALS AND METHODS

Twelve cross-bred dogs of about six months of age were used in this study. These dogs, of unknown history, were obtained from a small village (Kangemi) close to the Faculty of Veterinary Medicine. On acquisition, each dog was identified and held in isolation kennels for one month. They were examined for evidence of disease and treated with thenium compound tablets[h], every two weeks for three treatments. All dogs were vaccinated against canine distemper and canine contagious hepatitis using a combined tissue-culture-adapted (living)

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[h] Ancaris - Burroughs Wellcome and Co., London, England.

vaccine[i] and against leptospirosis using an inactivated combined *Leptospira canicola* and *L. icterohaemorrhagiae* vaccine[j]. Every two weeks for the entire period of the experiment, the dogs were washed with an acaricidal dog wash[k].

Later all the dogs were transferred to individual concrete floored kennels with runs, within a single building which was surrounded by a water filled moat. The dogs were fed a commercial dog meal daily and water was provided *ad libitum*. All dogs were treated with tetracycline hydrochloride at 66 mg per kg , daily, for 14 consecutive days. They were tested for *E. canis* using the cell culture test and re-treated with tetracycline hydrochloride at the same dosage for a further 14 days. While in kennels, blood was also taken for routine haematological and biochemical analysis.

One splenectomised adult cross-bred dog (Case 16761) was kept solely as the initial infection source. This dog was treated in the same manner as the 12 young cross-bred dogs. When a definite clinical case of ehrlichiosis was diagnosed at the clinic, blood smears were examined to rule out the possibility of *B. canis* infection. Blood was taken for the

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[i] Epivax T.C. plus - Wellcome Research Laboratories, Beckenham, England.

[j] Leptovax plus - Wellcome Research Laboratories, Beckenham, England.

[k] Pulvex dog wash - Chlorpyriphos, Wellcome Kenya Ltd., Kenya.

cell culture test and 10 ml of blood in 0.2 ml of 1% sodium heparin solution was inoculated into the splenectomised dog (Case 16761). Body temperature was recorded daily and blood for routine haematological and serum biochemical analysis was taken two to three times a week.

Blood smears were examined for *E. canis* and blood was taken for the cell culture test when the dog developed pyrexia. When *E. canis* was confirmed, 5 ml of blood in sodium heparin was inoculated intravenously into each of eight of the young cross-bred dogs. The four remaining dogs were kept as uninfected controls.

The rectal temperature, appetite and nature of faeces of each dog was monitored daily. Any evidence of emesis was recorded. Blood was collected from each dog two to three times a week for routine haematological and serum biochemical analysis as described in Chapter 2. Before the dogs were bled, they were examined physically. The colour of mucous membranes, pulse rate, presence or abscence of nasal and ocular discharge, lymph node size and spleen size by abdominal palpation, were noted. Blood for the cell culture test was taken every two weeks and the dogs were weighed weekly.

RESULTS

Although Case 16761, the splenectomised dog which was used as the source of experimental infection, did not show clinical signs of canine babesiosis, *B. canis* organisms were found in

its blood six days after it had been infected with *E. canis*. The dog was treated with a single subcutaneous injection of 5% phenamidine isethionate solution at 0.3 mg per kg. The dog developed pyrexia on Day 11 post infection but *E. canis* was first cultured from the blood on Day 14. The first clinical signs of ehrlichiosis were seen on Day 24 post infection and consisted of an increased pulse rate and slight pallor of mucous membranes. The body temperature was within normal limits at this stage and remained so for the rest of the experiment. Weight loss was noticed during the fourth week, which persisted until the twelfth week after infection, after which the weight steadily increased. Other clinical signs seen were depression, nasal and ocular discharge, lymph node enlargement and blood in the faeces.

The eight cross-bred dogs all developed signs of ehrlichiosis. However, these were mild and transient except in Case 16757 which died 79 days after infection. The other seven dogs recovered and showed no further clinical or laboratory abnormalities (Appendix 1 - 12). The first clinical sign detected was an increase in the pulse rate between the 9th and the 19th day (average 14.7 days) post infection, with one dog having an initial increase in pulse rate on Day 37 post infection. Seven of the eight infected dogs had a pulse rate of over 120 per minute. Pyrexia was noticed in seven of the eight dogs. The increase in body temperature (over 39.2°C)

occurred from Day 16 to Day 32 (average 25.3 days) post infection, with one exception on Day 5. A biphasic temperature elevation was evident; with one dog having a temperature peak on three different occasions.

The following clinical signs were also recorded in the young infected dogs: emesis (4 dogs), depression (1 dog), weight loss (6 dogs), pallor of mucous membranes (5 dogs), splenomegaly (2 dogs), abdominal pain (2 dogs), serous ocular and nasal discharges (3 dogs), partial anorexia (1 dog) and blood in the faeces (2 dogs). Clinical signs were not seen in the uninfected dogs.

The packed cell volume did not fall below 37% in four of the eight infected dogs. One dog, Case 16756 had a low packed cell volume (36%) when it was infected. Three dogs (Cases 16754, 16755 and 16757) had packed cell volumes which fell below 37% on Days 22, 22 and 26 post infection respectively (average 23.3 days). The packed cell volume remained low (below 37%) for 29 days, 15 days and 53 days respectively (average 32.3 days) and rose to preinfection levels in the first two dogs but persisted until death in the third dog (Case 16757).

The leucocyte count did not decrease below 7 500 per cu mm in six of the eight dogs. One dog (Case 16755) had a leucocyte count of 7 500 per cu mm on Day 32 post infection and the other dog (Case 16757) had a leucocyte count of 7 000 per cu mm on Day 37, Day 53 and Day 60 post infection, which then decreased

until death on Day 79 post infection.

The platelet count decreased below 200 000 per cu mm in all eight dogs. This decrease occurred between Day 26 and Day 47 post infection (average 32.5 days) and rose periodically, except in one dog (Case 16757) in which it decreased until death. The clinical, haematological and post-mortem findings in this case have been reported in detail.

Blood from seven of the eight infected dogs could be positively cultured for *E. canis*. On culture of its blood one dog (Case 16756) remained negative for *E. canis* even though it did show mild, transient clinical signs.

The cell culture test indicated that three of the four uninfected dogs (Cases 16752, 16758 and 16759) remained positive for *E. canis* even after two treatments of tetracycline hydrochloride at 66 mg per kg, per day, for 14 consecutive days. Although they did not show clinical signs of ehrlichiosis, there was the occasional minor change in their blood parameters which were consistent with the disease.

Experimentally Infected Case of Ehrlichiosis (Case 16757)

Case 16757 was a six month old, male, cross-bred dog. On the day of inoculation (Day 0), the dog's packed cell volume was 45%, leucocyte count was 14 300 per cu mm and platelet count was 384 000 per cu mm. The body temperature was 37.8°C, pulse rate was 100 per minute and body weight was 16.4 kg. The cell culture test was negative for *E. canis*. The dog was then

infected with *E. canis* by intravenous injection of 5 ml of heparinized blood from a dog that had ehrlichiosis (Case 16761).

On Day 26 post infection, the dog's body temperature increased to 40.1°C and remained elevated for the following 25 days. Thereafter the temperature was within the normal range until death ensued on Day 79 post infection (Figure H). Nasal and ocular discharge was evident on Day 37, blood in faeces on Day 61 and emesis and pallor of mucous membranes were seen on Day 68 post infection. Body weight decreased from the fourth week post infection until death, by which time the dog had lost 5.9 kg.

Packed cell volume was 37% on Day 26 post infection and remained below this until death, except for two slight increases on Day 51 and 55, when the packed cell volume was 39% (Figure H). The leucocyte count was 7 000 and 5 900 per cu mm on Day 37 and 53 respectively (Figure I). In between these dates and thereafter the peripheral leucocyte count was within the normal range. After Day 60, however, the leucocyte count decreased steadily from 6 900 to 1 000 per cu mm on Day 73 post infection. Platelet count was normal until Day 47, when it was 160 000 per cu mm (Figure I). Thereafter it increased until Day 60 when it was 78 000 per cu mm and thereafter decreased steadily to 42 000 per cu mm on Day 76 post infection. The cell culture test was positive for *E. canis* on Day 11 post infection.

FIGURE H

EXPERIMENTAL CANINE EHRLICHIOSIS

CASE 16757. VARIATION OF PACKED CELL VOLUME AND BODY TEMPERATURE FOR 76 DAYS POST-INFECTION

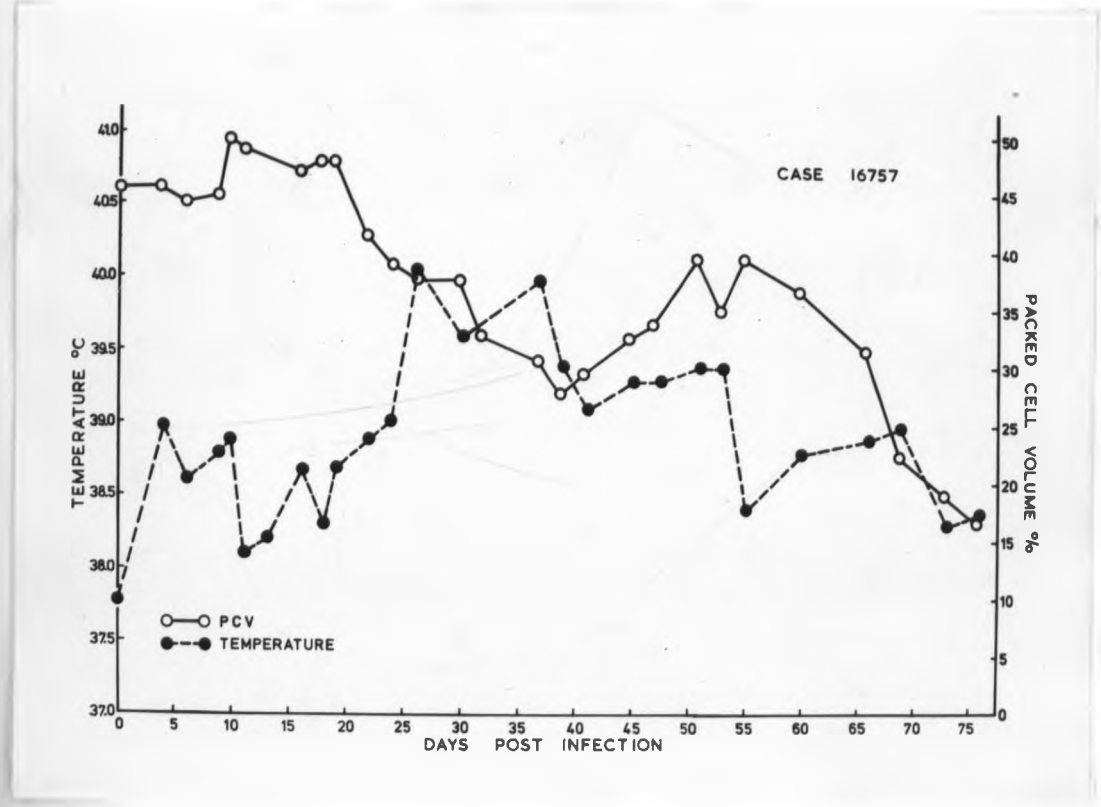
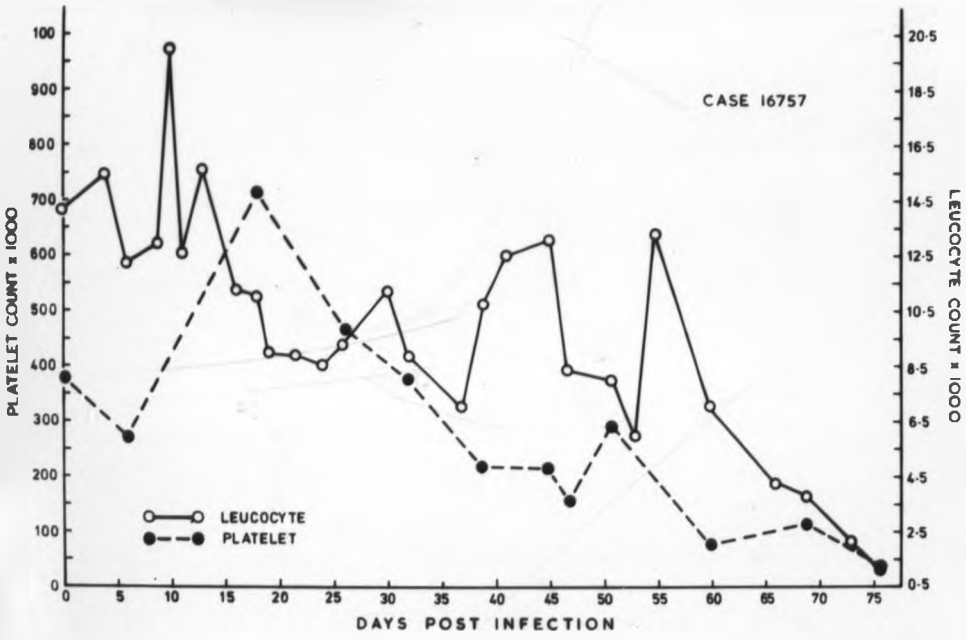


FIGURE I

EXPERIMENTAL CANINE EHRLICHIOSIS

CASE 16757. VARIATION OF LEUCOCYTES AND PLATELETS FOR 76 DAYS POST-INFECTION



A complete post mortem examination was carried out when the dog died on Day 79 post infection. The carcase was rather jaundiced. The superficial lymph nodes were enlarged, congested and oedematous. The mesenteric lymph nodes were prominently enlarged, reddish and oedematous. Histologically, the sinuses showed increased macrophage reaction and the lymphoid areas showed the prominent presence of plasma cells. In addition, the mesenteric lymph nodes showed very marked haemorrhage into the sinuses. The mesentery associated with these lymph nodes was haemorrhagic in places. From the duodenum to the caecum, numerous patches of petechial and occasionally ecchymotic haemorrhages were evident in the mucosa. Some haemorrhagic patches could be seen through the serosa (Figure J). Histological sections showed marked intermuscular haemorrhages. Similar haemorrhagic foci were also evident in the mucosa. The mucosa also showed moderate plasma cell reaction.

The kidneys had minute healed infarcts. One kidney had an ecchymotic haemorrhage. Histologically, there was a focus of haemorrhage in the cortex of the kidney with minute foci of mononuclear cell infiltration in the interstitium. The spleen was moderately enlarged and congested. The liver was slightly swollen and pale. However post-mortem changes obscured any other lesions.

Both lungs were oedematous and had petechial and ecchymotic haemorrhages (Figure K). Histologically there was prominent congestion and areas of compensatory emphysema. The heart had

FIGURE J

EXPERIMENTAL CANINE EHRLICHIOSIS

CASE 16757. HAEMORRHAGIC LESIONS OF THE INTESTINE AND MESENTERY

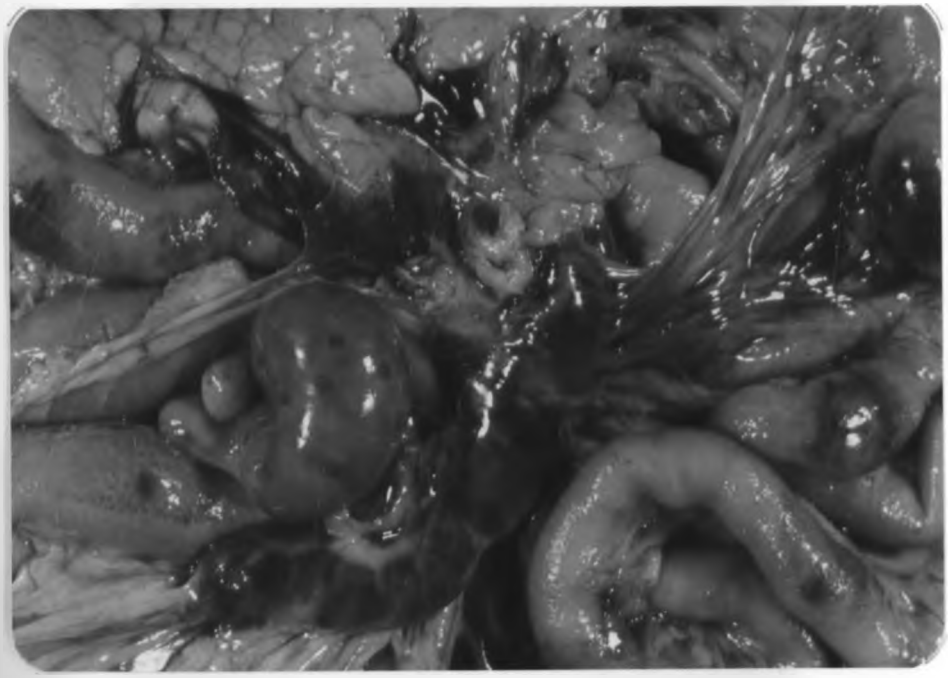
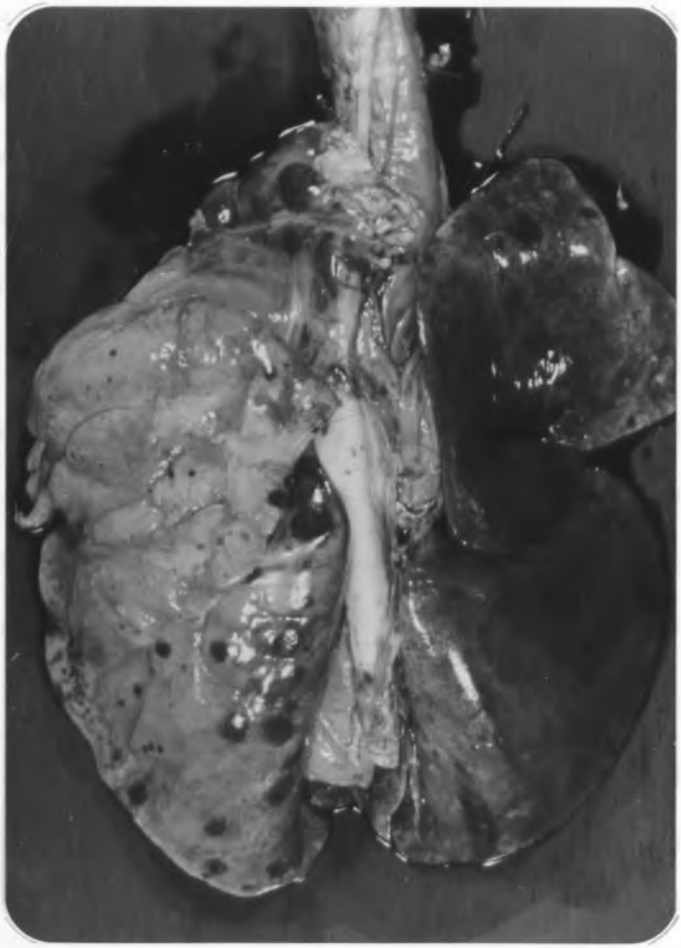


FIGURE K

EXPERIMENTAL CANINE EHRLICHIOSIS

CASE 16757. PETECHIAL AND ECCHYMOTIC HAEMORRHAGES ON THE LUNGS



petechial and a few ecchymotic haemorrhages under the epicardium and in the left endocardium (Figure L). Histology revealed some haemorrhages between myocardial fibres.

DISCUSSION

In an attempt to define the disease syndrome of ehrlichiosis in Kenya, eight cross-bred dogs were infected with *E. canis* by blood inoculation. These dogs developed mild, transient clinical signs from which seven dogs recovered spontaneously. One dog died 79 days post infection. The mild,transient clinical signs were consistent with those shown by naturally occurring cases presented to the clinic. It is thought that some form of stress at the time of clinical disease would precipitate the more severe clinical form of the disease.

Blood in faeces is considered to be one of the signs of the haemorrhagic syndrome, which is believed to be immunological in origin (Scott, 1978). Of the two experimentally infected cases that showed blood in faeces, one recovered spontaneously and the other developed pancytopenia and died 79 days post infection.

All eight dogs showed mild transient anaemia, leucopenia and thrombocytopenia. These parameters varied between individual dogs. The independent decreases in erythrocytes, leucocytes and platelets are also consistent with the haematological findings from naturally occurring cases presented to the clinic. In the majority of these cases, true pancytopenia rarely accompanied clinical disease.

FIGURE L

EXPERIMENTAL CANINE EHRLICHIOSIS

CASE 16757. PETECHIAL AND ECCHYMOTIC HAEMORRHAGES ON THE EPICARDIUM

Only one experimentally infected dog developed pancytopenia. This dog had petechial and ecchymotic haemorrhages of the internal organs and plasma cell infiltration of the lymph nodes, on post mortem examination. These post mortem findings are consistent with those described by Huxsoll *et al.* (1970a), Hildebrandt *et al.* (1973b) and Robinson and Garner (1973).

Tetracycline hydrochloride at 66 mg per kg did not clear the control dogs of *E. canis* and the organism could be cultured irregularly from the blood of three of the four uninfected dogs for some months. This finding is in contrast to the experience of Davidson *et al.* (1978) but agrees with the findings of Amyx *et al.* (1971) and Buhles *et al.* (1974) as has been discussed in Chapter 4.

Since it was difficult to obtain experimental dogs that were free of *E. canis* infection, subsequent experiments were carried out on puppies that had been born and reared in tick-free kennels (Chapter 5).

Since three of the four uninfected control dogs remained carriers of *E. canis* despite treatment, it must be presumed that some of the infected dogs also remained carriers and hence would have showed very mild clinical signs or no clinical signs at all. The experimental findings may also be due to the fact that young animals show a milder clinical response to disease than older animals or that these dogs may have built up an immunity to the disease due to their early exposure. It could also be hypothesised that older dogs developed an immunity which was not necessarily protective (hypersensitivity?).

CHAPTER 4

A COMPARISON OF TETRACYCLINE HYDROCHLORIDE, DOXYCYCLINE AND IMIDOCARB DIPROPIONATE IN THE TREATMENT OF CANINE EHRLICHIOSIS

Tetracyclines have been used successfully in both the prophylaxis and chemotherapy of experimental and natural *E. canis* infections (Cassard, 1957; Amyx *et al.*, 1971; Davidson *et al.*, 1978) and they are the accepted form of treatment. Recently Adenyanju and Aliu (1977) reported the successful treatment of canine ehrlichiosis with a single injection of imidocarb dipropionate (Imizol). Doxycycline is a broad-spectrum, semi-synthetic tetracycline analogue which attains effective human blood concentrations with a single daily dose (Leibowitz, Hakes, Cahn and Levy, 1972). Gothe and Lämmler (1971) found that the most effective tetracycline compounds for treatment of *Aegyptianella pullorum* infection in the fowl were parenteral oxytetracycline, rolitetracycline and oral doxycycline. Prophylactically, doxycycline proved to be the most effective compound. Krause, Perine, McDade and Awoke (1975) showed that a single oral dose of doxycycline was as effective as the conventional multidose treatment with chloramphenicol or tetracycline for Louse-borne typhus fever of man. Since the causative agent of Louse-borne typhus fever is a rickettsia,

Rickettsia prowazeki and *A. pullorum* is also a rickettsia, it was decided to test doxycycline in the treatment of *E. canis* infections.

In this chapter we examine and compare the efficacy of tetracycline hydrochloride, doxycycline and imidocarb dipropionate in the treatment of naturally occurring *E. canis* infections and on their ability to eliminate the infection. Treatment of combined *B. canis* and *E. canis* infections and the side effects following imidocarb dipropionate administration will also be discussed.

MATERIALS AND METHODS

The dogs were presented at the Small Animal Clinic of the Faculty of Veterinary Medicine, University of Nairobi, and represented a wide variety of breeds and cross-bred dogs, kept under varying conditions of tick control. The cases reported in this study were those tested, treated and retested for infection by the cell culture technique.

A presumptive diagnosis of ehrlichiosis was made from some or many of the following clinical signs: pyrexia (over 39.2°C), depression, pallor of mucous membranes, anorexia or selective appetite, weight loss, splenomegaly, lymphadenopathy, vomiting, diarrhoea, epistaxis, haematuria, haematemesis, blood in faeces and haemorrhages in the mucous membranes and skin.

Two blood samples were taken from each animal, one for preparation of blood smears and haematology and the other for

attempted isolation of *E. canis* in culture as has been described in Chapter 2.

Acute cases of ehrlichiosis or concurrent babesiosis and ehrlichiosis were treated immediately whilst suspected cases of ehrlichiosis were not treated until the results of the cell culture test were known. Since imidocarb dipropionate [3,3'-bis-(2-imidazolin-2-yl)-carbanilide dipropionate] and doxycycline (6-deoxy-5-oxytetracycline) were drugs which were under trial for treatment of canine ehrlichiosis, owners were given the choice of either the conventional tetracycline hydrochloride or doxycycline for 14 days of oral administration or two injections of imidocarb dipropionate. Doxycycline was preferred in cases with renal insufficiency or in dogs that were sensitive to tetracycline hydrochloride.

Tetracycline hydrochloride Therapy

Tetracycline hydrochloride was administered orally at a dosage of 66 mg per kg or less, per day, in a divided dose for 14 consecutive days. No other antibiotic or supportive treatment was administered to any of the dogs except when concurrent babesiosis was present. Dogs with concurrent infections of *B. canis* and *E. canis* were treated with a single subcutaneous injection of phenamidine solution and tetracycline hydrochloride at 66 mg per kg or less, per day for 14 days. Forty-eight hours to seven days after the last dose of tetracycline, the dogs were retested for canine ehrlichiosis using the cell culture test.

Doxycycline Therapy

Doxycycline was administered orally at a dosage of 10 mg per kg or more, per day, in a single dose for 14 consecutive days. No other antibiotics or supportive treatment was administered to any of the dogs except when concurrent babesiosis was present and these were treated with a single subcutaneous injection of phenamidine solution and doxycycline at 10 mg per kg or more, per day, for 14 days. Three to seven days after the last dose of doxycycline, the dogs were retested for canine ehrlichiosis.

Imidocarb dipropionate Therapy

Dogs with either uncomplicated infections of *E. canis* or concurrent *E. canis* and *B. canis* infections were treated with two intramuscular injections of imidocarb dipropionate, at an interval of two weeks. Thirty days and sixty days after the last injection of imidocarb, the dogs were retested for *E. canis* using the cell culture test. The different interval used to retest dogs after treatment with imidocarb was because of the reported persistence of relatively high levels of the drug in tissues following treatment (Wellcome Foundation, pers. comm.).

In this study it was difficult to calculate accurately the dosage of tetracycline hydrochloride and doxycycline since the drugs were dispensed in capsules of 250 mg and 100 mg respectively. Hence the actual dose given to the patient was that calculated to the nearest capsule. Tetracycline hydrochloride, being used at a much higher dose level

and being known to cause vomiting, was used at 66 mg per kg or less; being reported here as being either at the high dose level or the low dose level. Doxycycline did not show any side effects, hence it was used at a dose of 10 mg per kg or higher. Imidocarb dipropionate being a solution could be accurately calculated, depending on the weight of the dog.

RESULTS

During the period of this study, 750 cases of ehrlichiosis were diagnosed representing 8% of animals presented to the clinic. Of these, 153 were retested following treatment using the cell culture test. In this group, 63 dogs were treated with tetracycline hydrochloride, 27 with doxycycline and 63 with imidocarb dipropionate.

Tetracycline hydrochloride at 66 mg per kg produced a marked clinical improvement, with increasing packed cell volume and improved appetite within three to four days, in most cases. However, many of these cases showed a recurrence of clinical signs within a month or two of treatment. Sixteen of the 63 cases treated with tetracycline hydrochloride had concurrent babesiosis. These dogs were treated with phenamidine isethionate solution. A brownish discolouration of the deciduous teeth in young puppies or of the permanent teeth in older puppies was seen in dogs given tetracycline hydrochloride when their teeth were erupting.

Doxycycline at 10 mg per kg also produced a marked clinical improvement within three to four days in most cases. However, as with the group treated with tetracycline hydrochloride, many of these cases also remained infected with *E. canis* and showed a recurrence of clinical signs. Three of the 27 cases treated with doxycycline had concurrent babesiosis and were treated with phenamidine isethionate solution.

Imidocarb dipropionate treatment produced clinical improvement in uncomplicated ehrlichiosis in seven to 14 days. Four cases showed no improvement. They had been previously treated with tetracycline hydrochloride without remission of signs and were later found to have other complicating diseases. In 14 cases with concurrent *B. canis* and *E. canis* infections, clinical improvement was noticed within 24 hours. *Babesia canis* could not be found in blood smears two to three days after treatment although two dogs were found positive for *B. canis* one month later, possibly due to reinfection.

Imidocarb dipropionate frequently elicited a marked but brief pain response during injection but did not cause lameness or swelling at the site of intramuscular injection. Within ten minutes of the injection, a large number of dogs showed some or all of the following: profuse salivation, serous ocular discharge, diarrhoea or depression. Delayed reactions occurred in four dogs, ten to 12 hours after the imidocarb dipropionate. These reactions consisted of oedematous swellings of the conjunctiva in two cases and depression, shivering and a high

body temperature (41°C) in the other two.

Since no difference in therapeutic efficiency against clinical signs of *E. canis* was noted between the various dosages of tetracycline hydrochloride, the lower dose level was used in the majority of cases. The higher dose levels tended to cause vomiting. In nine of the 38 dogs on the lower dose level, *E. canis* could not be isolated in culture 48 hours to seven days following the last treatment of tetracycline hydrochloride (Table 15). Of the 25 dogs on the higher dose level, seven were cleared of infection. Eight of the 27 dogs treated with doxycycline were cleared of *E. canis* infection, although all dogs showed a clinical improvement.

Ehrlichia canis could not be cultured from the blood of 51 of the 63 cases treated with imidocarb dipropionate (Table 15) 30 or 60 days after treatment. Five dogs kept under strict tick control following imidocarb dipropionate treatment remained negative for *E. canis* for a period of six months.

DISCUSSION

The routine use of cell culture isolation has greatly improved the diagnosis of canine ehrlichiosis and has provided a means of assessing the ability of drugs to eliminate the causal organisms.

The clinical improvement of *E. canis* - infected dogs following tetracycline treatment reported by many workers (Cassard, 1957; Amyx *et al.*, 1971; Buhles *et al.*, 1974) has

TABLE 15

SUMMARY OF THE NUMBER OF DOGS WITH CANINE EHRLICHIOSIS TREATED WITH TETRACYCLINE HYDROCHLORIDE, DOXYCYCLINE AND IMIDOCARB DIPROPIONATE AND THE NUMBERS IN WHICH THE PARASITE WAS ELIMINATED

	TETRACYCLINE HYDROCHLORIDE THERAPY		DOXYCYCLINE THERAPY	IMIDOCARB DIPROPIONATE THERAPY
	≤66 mg/kg	66 mg/kg	10 mg/kg	5 - 7 mg/kg
No. of dogs treated and retested	38	25	27	63
No. of dogs with positive *E. canis* cultures after therapy	29 (76.3%)	18 (72.0%)	19 (70.4%)	12 (19.0%)
No. of dogs with negative *E. canis* cultures after therapy	9 (23.7%)	7 (28.0%)	8 (29.6%)	51 (81.0%)

been confirmed. Amyx *et al.* (1971) reported that the infection was not eliminated by tetracyclines. Buhles *et al.* (1974) however, found that when tetracyclines were used in persistent infections, the *Ehrlichia* were difficult or impossible to detect in blood smears although they may have remained undetected in some other host tissue. They also found that these dogs were apparently susceptible to reinfection.

Tetracycline hydrochloride achieved an overall clearance of infection in 25% of cases in this study. A few dogs reacted to the high level of oral tetracycline hydrochloride by vomiting. Dogs which reacted to tetracyclines at 66 mg per kg were given a lower dosage or the total daily dosage was divided into three or four oral treatments per day instead of two.

Using doxycycline treatment, 30% of the 27 cases were cleared of *E. canis* infection. Immelman (1977) showed that a single dose of 100 mg per kg body weight of doxycycline gave adequate blood levels in dogs. The accepted therapeutic level in animals, for oxytetracycline to susceptible bacteria, is a blood concentration of 0.5 to 1.0 mg per ml. However, further work is definitely required on the action of doxycycline on rickettsia in dogs.

Recently Adeyanju and Aliu (1977) reported that a single injection of imidocarb dipropionate was effective in treating both canine ehrlichiosis and babesiosis in Nigeria. They were unable to detect parasites in blood smears two to six weeks

after treatment. Although our study was concerned with the treatment of canine ehrlichiosis with imidocarb dipropionate, we have also used this drug successfully in the treatment of of *B. canis* infection. Following two treatments with imidocarb dipropionate at 5 to 7 mg per kg , 14 days apart, most dogs showed clinical improvement and 81% were cleared of *Ehrlichia*. A small proportion of these dogs were kept under strict tick control and *Ehrlichia* could not be detected over a period of six months. Thus imidocarb dipropionate was effective in treating both *B. canis* and *E. canis* and in eliminating the *Ehrlichia* in a large proportion of cases. A disadvantage of this drug is its side effects. Although these effects were not too severe, they were distressing and as a routine, treated dogs were kept under observation for ten to 15 minutes. It has also been suggested that these cholinergic signs could be controlled by the use of atropine sulphate (Wellcome Foundation Ltd., pers. comm.).

Although tetracyclines (tetracycline hydrochloride and doxycycline) remain a very useful treatment for canine ehrlichiosis, imidocarb dipropionate has certain advantages. It can be used in two treatments by injection and has none of the problems attached to long term antibiotic treatment. It is effective in treating both canine ehrlichiosis and babesiosis. It also proved to be more efficient in eliminating the parasite than the tetracyclines, an important epidemiological consideration as *Ehrlichia* is not transovarially transmitted

by the tick (Groves *et al.*, 1975). This could greatly assist in the control and elimination of the disease, especially where effective tick control is in practice.

CHAPTER 5

FREE-LIVING JACKALS *(CANIS MESOMELAS)* RESERVOIR HOSTS FOR *EHRLICHIA CANIS* IN KENYA

Experimental infections with *E. canis* have been studied in the silver-backed jackal, *Canis mesomelas* (Neitz and Thomas, 1938), the coyote, *Canis latrans* (Ewing *et al.*, 1964), the American red fox, *Vulpes fulva* and the gray fox, *Urocyon cinereoargenteus* (Amyx and Huxsoll, 1973). Neitz (1967) reported a fatal case of canine ehrlichiosis in a silver-backed jackal after exposure to ticks. The silver-backed jackal is widely distributed in Kenya (Dorst and Dandelot, 1970) and may come into contact with domestic dogs living on the outskirts of the large towns. Jackals are also commonly seen close to small villages and isolated manyattas. Many of the pastoral communities keep domestic dogs both as guard dogs and to herd their livestock. These dogs and jackals therefore have the opportunity to intermingle.

This was an epidemiological study designed to examine free-living jackals from pastoral areas of Kenya and dogs owned by Masai and Turkana people for the presence of *E. canis*.

MATERIALS AND METHODS

Animals used:

(a) Jackals

Sixteen adult silver-backed jackals were studied. Nine jackals were shot just outside the Mara Game Reserve in Kenya, one jackal was found with a suspected hip fracture in Nairobi National Park, three jackals were live-trapped at Athi River and three jackals were captured on the Loita Plains, Narok District, by drug immobilization using 200 mg ketamine hydrochloride [1] in projectile syringes.

The jackals that were captured at Athi River (Jackals 11, 12 and 13), on the Loita Plains (Jackals 29, 30 and 31) and in Nairobi National Park (Jackal 4) were anaesthetized with ketamine hydrochloride, using 25 mg per kg and then brought to the clinic. Jackals 12, 29, 30 and 31 were held in captivity.

(b) Hyaenas

Eight spotted hyaenas *(Crocuta crocuta)* were used in this study. These were live-trapped in the Mara area, Narok District.

(c) Domestic dogs

There were eight Masai owned domestic dogs from Narok District, four Masai owned domestic dogs from Konza area, Kajiado District and 11 Turkana owned domestic dogs from

[1] Ketalar - Laboratories Parke-Davis, S.A.E. Madrid, Spain.

Kakuma, Turkana District.

Since there was a high incidence of canine ehrlichiosis in Kenya, it was difficult to obtain dogs which were free of the disease (Chapter 3). Thus it was decided to rear uninfected puppies by whelping a bitch in tick-proof kennels.

The kennels were vacated and thoroughly cleaned. All surfaces (floors and walls) were rendered smooth by filling in cracks and holes. The walls and floor of the entire building were then treated with an ixodicidal chemical [m], applied at a concentration of 0.25% w/v. Four weeks later, a small batch of healthy *R. sanguineus* ticks were placed in the kennels. One hour later all the ticks were dead. All dogs entering the kennels were washed thoroughly with Pulvex dog wash. The tick moat was kept filled with water. A pregnant bitch, shown to be negative for *E. canis* by the cell culture test, was whelped in the kennels. Her pups were tested periodically for *E. canis* using the cell culture test and were consistently found to be negative.

Samples collected:

(a) Blood

Blood was collected for a complete haematological examination and serum biochemical analysis (Chapter 2) from the jackals and domestic dogs. In the field whole blood was

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[m] Permethrin 25% w/w wettable powder - Wellcome Kenya Ltd.

allowed to clot and the serum decanted and stored. The serum and the blood in ethylenediaminetetraacetic acid were kept on ice until they were examined at the clinic.

Blood from all the jackals, hyaenas and domestic dogs were tested for *E. canis* organisms by the cell culture test. In the jackals that were bled in the field, 10 ml of whole blood was drawn into a sterile haparin-coated syringe. A second needle was fitted and bent at right angles and the syringe taped to a convenient tree. The syringe was not moved until the blood had sedimented. Two millilitres of plasma were transferred through the bent needle into sterile Leighton tissue culture tubes. After 2 to 4 days, the coverslips from the Leighton tubes were washed in saline and the cells on the coverslips fixed with methanol. At the clinic, the coverslips were stained with Giemsa and the cells examined for the presence of *E. canis* morulae as has been described in Chapter 2.

Since jackal blood took a very long time to sediment, an additional 20 ml of heparinized blood was placed in a sterile universal bottle and centrifuged at 150 G for 10 minutes. The plasma was then transferred to Leighton tubes and the culture test carried out as previously described.

Infected leucocytes from Jackals 29 and 30 were established in culture and were inoculated intravenously into 2 three-month old, cross-bred puppies. These puppies had been born and reared under tick-free conditions as has been described. A litter mate

kept under similar conditions was used as an uninfected control. Clinical signs and haematological parameters were monitored in these puppies. When the puppies showed clinical signs indicative of ehrlichiosis, blood was taken for the cell culture test.

(b) Ticks

Ticks on the jackals and domestic dogs were collected and identified.

(c) Intestinal parasites

Wherever possible, the whole intestinal tract was examined for internal parasites. The intestinal tracts were kept on ice until they were examined at the clinic.

RESULTS

Blood samples:

(a) Jackals

Eight of the 16 free-living jackals tested were shown to harbour *E. canis* by the cell culture test. This number may have been higher, but for the difficulties encountered with the test under field conditions. Jackal blood took three to five hours to sediment, even in animals which harboured *E. canis*. Many of the samples were heavily contaminated with bacteria or had microfilariae which interfered with the test. There was no morphological difference in the cells which were collected by slow centrifugation and those collected by the sedimentation technique. In samples from animals infected with microfilariae,

the microfilariae prevented cells from settling on the coverslips in the Leighton tubes. The microfilariae were identified as *Dipetalonema reconditum* (J.H. Arundel, pers. comm.*).

(b) Hyaenas

The blood from all eight hyaenas which was examined for *E. canis* was negative. However, the blood sedimented within 15 to 20 minutes.

(c) Domestic dogs

The blood from 6 of the 8 domestic dogs from Narok District were positive for *E. canis* by the cell culture test. All four of the domestic dogs from Kajiado District were shown to harbour *E. canis*, while only four of the 11 dogs examined from Turkana District were positive. The blood from these infected domestic dogs sedimented within 60 minutes.

Haematological findings in the free-living jackals and domestic dogs are given in Table 16. In general, the packed cell volume of the pastoral domestic dogs (34%) was lower than that of the free-living jackals (41%), (Appendix: A 13, A 14). Serum biochemical parameters were examined only from free-living jackals (Table 17), (Appendix: A 15).

The two puppies inoculated with leucocyte culture material from Jackals 29 and 30 showed mild clinical disease. Dog A inoculated with cells from Jackal 30 had a biphasic temperature

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TABLE 16

HAEMATOLOGICAL FINDINGS IN FREE-LIVING JACKALS AND MASAI OWNED DOMESTIC DOGS IN NAROK AND KAJIADO DISTRICTS

PARAMETER	JACKALS			DOGS		
	Mean	Range	Number	Mean	Range	Number
Packed cell volume (%)	41	25 - 54	15	34	16 - 42	12
Haemoglobin (g/100 ml)	14.0	8.8 - 18.8	15	11.2	5.2 - 13.7	12
Erythrocytes X 10^3 /mm^3)	5.63	3.56 - 7.44	15	4.9	2.48 - 6.04	12
Leucocytes/mm^3	10 727	2 700 - 22 300	15	18 950	10 800 - 61 800	12
Neutrophils/mm^3	7 897	1 728 - 17 840	14	10 221	4 428 - 38 934	12
Lymphocytes/mm^3	2 855	585 - 5 940	14	6 390	2 641 - 11 742	12
Monocytes/mm^3	175	0 - 2 453	14	41	0 - 276	12
Eosinophils/mm^3	325	0 - 1 056	14	2 365	648 - 11 124	12
Basophils/mm^3	48	0 - 669	14	0	0	12
Mean cell volume (μ^3)	78	69 - 94	15	71	67 - 78	12
Mean cell haemoglobin concentration (%)	34.1	31.2 - 38.0	15	33.3	31.0 - 36.4	12
Total protein (g/100 ml)	6.9	5.2 - 11.0	15	7.5	5.4 - 9.4	12

TABLE 17

SERUM BIOCHEMICAL ANALYSIS IN FREE-LIVING JACKALS IN NAROK AND KAJIADO DISTRICTS

PARAMETER	MEAN	RANGE	NUMBER
Urea nitrogen (mg/100 ml)	48.00	10.00 - 75.00	12
Phosphorus (mg/100 ml)	4.19	3.74 - 4.65	6
Calcium (mg/100 ml)	7.60	5.19 - 9.50	5
Alkaline phosphatase (King Armstrong units)	5.57	4.80 - 6.47	6
Serum glutamic pyruvic transaminase (Reitman Frankel units)	18.00	12.00 - 30.00	6
Total protein (g/100 ml)	6.10	4.60 - 7.25	9
Albumin (g/100 ml)	3.40	2.35 - 4.60	9
Globulin (g/100 ml)	2.70	1.50 - 3.90	9
Albumin/Globulin ratio	1.50	0.73 - 2.66	9

rise to 39.5°C on Day 4 and ten days later to 39.3°C. Dog B inoculated with cells from Jackal 29 had a temperature of 39.8°C on Day 3. Transient anorexia and depression were seen in both dogs and Dog A had splenomegaly. However, these clinical signs were very mild and the puppies were clinically normal after three weeks. Seven to nine days after inoculation, Dog B showed mild transient anaemia and leucopenia. On Days 9 and 5 post inoculation, Dog A and Dog B were shown to harbour *E. canis* organisms by the cell culture test (Appendix: A 16, A 17, A 18).

Ticks

The tick species found on the jackals from Narok and Kajiado Districts are given in Table 18. *Haemaphysalis leachii* was the most commonly encountered tick, being present on 11 of the 12 jackals that harboured ticks. *Rhipicephalus simus* was found on seven jackals while *R. sanguineus* was only found on five jackals (Appendix: A 19). In general, domestic dogs harboured fewer ticks than free-living jackals. Only five of the ten dogs examined had *H. leachii* and five dogs had *R. sanguineus* (Appendix: A 20).

Intestinal parasites

The intestinal parasites found in the free-living jackals are listed in Table 19. Five of the six jackals examined were found to have *Ancylostoma caninum* while only two jackals harboured *Toxocara canis*. The *Taenia* species could not be further identified (J.H. Arundel, pers. comm.).

TABLE 18

TICK SPECIES FOUND ON 12 FREE-LIVING JACKALS

AND 10 PASTORAL DOMESTIC DOGS

TICK SPECIES	JACKALS	DOGS
Rhipicephalus sanguineus	5/12	5/10
Rhipicephalus simus	7/12	2/10
Rhipicephalus appendiculatus	0/12	3/10
Rhipicephalus pulchellus	0/12	2/10
Amblyomma nymphs	6/12	1/10
Amblyomma variegatum	1/12	2/10
Haemaphysalis leachii	11/12	5/10

TABLE 19

INTESTINAL PARASITES FOUND IN FREE-LIVING JACKALS

IN NAROK AND KAJIADO DISTRICTS

JACKAL NUMBER	*ANCYLOSTOMA CANINUM*	*TAENIA* SPECIES	*TOXOCARA CANIS*
Jackal 6	2		3
Jackal 8	40		4
Jackal 9		1	
Jackal 10	16	3	
Jackal 11	4		
Jackal 13	6		

DISCUSSION

Silver-backed jackals have been experimentally infected with *E. canis* (Neitz and Thomas, 1938) and one jackal was infected by exposure to ticks (Neitz, 1967). This study has identified the presence of natural infection with *E. canis* in free-living jackals in Kenya. Domestic dogs owned by the pastoral communities in Narok, Kajiado and Turkana Districts were also shown to harbour *E. canis*. However, hyaenas from the same areas as the jackals and domestic dogs, tested with the same technique were found not to harbour the organism. This supports the opinion that *E. canis*, even in free-living animals, is restricted to Canidae (Huxsoll, 1976).

Clinical disease was not evident in captured jackals in this study and infection was only identified by *in vitro* culture. The cells from cultures were inoculated into susceptible puppies. The mild transient disease observed in these puppies was similar to that seen in cross-bred puppies infected with blood from domestic dogs in the acute phase of ehrlichiosis (described in Chapter 3).

Coyotes (Ewing *et al.*, 1964) and foxes (Amyx and Huxsoll, 1973) were inoculated with blood from infected dogs in the acute phase of ehrlichiosis, the phase which has the highest parasitaemia. Foxes that were experimentally infected with *E. canis* only, showed minor changes such as mild anaemia, thrombocytopenia and leucopenia in the acute stages of infection

but there was no evidence of clinical disease (Amyx and Huxsoll, 1973). Two coyotes that were experimentally infected with *E. canis* and *B. canis*, developed morulae of *E. canis* in their peripheral blood eight days after inoculation (Ewing *et al.*, 1964). The severe disease described in these two coyotes was possibly due to the concomitant infection with *B. canis*. The jackal that was infected with dog blood by Neitz (1967) showed no clinical signs of ehrlichiosis but did harbour the causative organism for 112 days.

Since jackal blood had to be left in syringes for up to five hours before sedimentation took place, bacterial contamination frequently occurred. To avoid this contamination, jackal blood was centrifuged very slowly and then cultured in Leighton tubes as described. This centrifugation of samples, did not appear to have an adverse effect on the mononuclear cells in any way. Microfilariae of *D. reconditum*, found in the Leighton tubes of infected jackals, prevented the cells from settling on the coverslip. There was little that could be done about this. Similar difficulties were encountered with the test with naturally occurring cases of ehrlichiosis and heart worm disease of domestic dogs seen at the clinic. Apart from these difficulties, the cell culture test worked well under field conditions. Environmental temperatures were high enough for the *E. canis* organisms to develop and multiply inside the cytoplasm of the mononuclear cells on the coverslips. Washing and fixing the cells on the coverslips, within the Leighton

tubes, enabled the cultures to be transported back to the clinic.

Rhipicephalus sanguineus is the only proven vector of *E. canis* in domestic dogs (Donatien and Lestoquard, 1936a; Groves *et al.*, 1975). Pastoral domestic dogs generally had fewer ticks than the jackals. *Rhipicephalus sanguineus* and *H. leachii* were equally common on these dogs but a greater number of jackals harboured more *H. leachii* than *R. sanguineus*. Although *E. canis* has now been confirmed in free-living jackals, the vector has not yet been identified. Further work on tick transmission of *E. canis* to jackals should be carried out, using both *R. sanguineus* and *H. leachii*.

The intestinal tracts of only six jackals were examined for intestinal parasites. Although *T. canis* has been reported previously in the golden jackal *(Canis aureus)*, the presence of *T. canis* in these silver-backed jackals is a new finding (J.H. Arundel, pers. comm.).

The pastoral domestic dogs that were tested in Narok and Kajiado Districts were those animals which were either too young or not well enough to follow the cattle when they were taken out of the manyattas to graze. Disease or the fact that the dogs were very young may be the reason for the low packed cell volume seen in these dogs. Although we did not check the intestinal parasites from the pastoral domestic dogs in Narok and Kajiado Districts, Eugster (1978) found a high prevalence of *A. caninum* in dogs in the Kajiado District. He found that 77 of 174 (44%) were infected, but did not give the level of infection. The

presence of these parasites may account for the low packed cell volume recorded in our study from the pastoral domestic dogs in this area.

The packed cell volume, haemoglobin, mean cell volume, mean cell haemoglobin concentration and leucocyte count of the silver-backed jackals found in this study were similar to the values recorded for the golden jackal (Hawkey, 1975). The low number of hookworms *A. caninum* found in five of the six jackals is possibly a reflection of acquired protective immunity (Wakelin, 1978), since all jackals in this study were adults. Normal blood urea nitrogen in domestic dogs is between 10 and 20 mg per 100 ml (Kirk, 1977). The higher blood urea nitrogen (48 mg per 100 ml) seen in the free-living jackals could be related to their high meat diet.

These studies indicate that domestic dogs are susceptible to infection with *E. canis* from jackals and provides further evidence that the infection is confined to the Canidae. Since the same tick species were found on both jackals and pastoral domestic dogs, tick sharing by jackals and domestic dogs may occur where the two species intermingle. Jackals may thus act as a reservoir host for *E. canis* in Kenya.

CHAPTER 6

GENERAL DISCUSSION

In 1976, Kaminjolo *et al.* confirmed the presence of *E. canis* in Kenya by cell culture isolation (Nyindo *et al.*, 1971) and the indirect fluorescent antibody test (Ristic *et al.*, 1972). Since then, modifications of the cell culture test have been used routinely in the clinic to confirm the diagnosis of canine ehrlichiosis. The smaller quantity of blood used in this modification has enabled the test to be used in dogs of all sizes. During the incubation of leucocyte rich plasma neither dog nor calf serum was added to the cells. This modified test was used successfully to test jackal blood under field conditions. Leucocyte rich plasma was then incubated at ambient temperature. Before the coverslips from the Leighton tubes were transported back to Nairobi, they were washed and fixed, so that movement did not disturb the cells, once they had settled on the coverslips. In animals with a very slow sedimentation rate, such as the jackal, the heparinized blood needed to be centrifuged very slowly. This method considerably shortened the time required for jackal blood to sediment and helped to prevent bacterial contamination of samples which would otherwise have had to be left to sediment over long periods. These modifications of the test could thus enable the test to be carried out in laboratories with limited facilities.

Morulae and initial bodies of *E. canis* could sometimes be

detected in Giemsa - stained peripheral blood smears in acute cases of ehrlichiosis. However, care was needed in differentiating between azurophilic granules in the lymphocytes and morulae of *E. canis*. Identification of these organisms was difficult or impossible in healthy carrier animals and chronic cases. Hence the mononuclear cell culture test was usually relied upon for a definite diagnosis.

Using the cell culture technique, ehrlichiosis was found to be the most frequently diagnosed medical disease entity at the clinic. A diagnosis was made in 8% of all cases presented at the clinic. Routine testing of working dogs such as those used by the police, armed forces and security organisations revealed a high incidence of healthy carrier animals. Field collection of blood from Masai and Turkana owned dogs in Narok, Kajiado and Turkana Districts identified the wide-spread occurrence of the disease. A country-wide survey using the indirect fluorescent antibody test would be very useful at this stage to determine the true prevalence of the disease in Kenya.

Greater awareness of the different forms of ehrlichiosis enabled clinicians to recognise the disease early and thus to initiate prompt treatment. In this way, many cases were treated before they progressed to the chronic form. Acute ehrlichiosis often occurred in association with babesiosis. Treatment of both diseases simultaneously or as soon as the ehrlichiosis was confirmed, resulted in rapid recovery. In some of these cases, where the ehrlichiosis remained untreated, they progressed to

one or more of the following: kidney failure, immunological defects such as frank haemorrhage, bleeding into the spinal column, abnormalities of the reproductive system or to a subclinical form of the disease. Recognition of the immunological form with frank haemorrhage and bleeding into the spinal column and its treatment with steroids and tetracycline hydrochloride often resulted in recovery.

The widely described signs of haemorrhage reported in the literature were seen in dogs representing most breeds. Since these clinical signs and the course of the disease differed from the accepted disease pattern of death following the acute or chronic bleeding form of ehrlichiosis elsewhere in the world, it was decided to infect dogs with *E. canis* in order to follow the course of the disease. Eight cross-bred dogs of approximately six months of age, were infected by intravenous inoculation with *Ehrlichia* positive blood. Seven of the dogs showed mild, transient clinical signs of ehrlichiosis and recovered spontaneously. One dog died 79 days post infection. The mild clinical signs seen in these dogs were consistent with the clinical signs shown by certain of the naturally infected dogs presented at the clinic. Two of the experimentally infected dogs developed haemorrhagic signs manifested by blood in their faeces, one of which died and the other recovered. Additional signs of the haemorrhagic form were not shown by any of these dogs. Naturally occurring cases have also been seen to recover from the mild form of the disease and later be presented with

the haemorrhagic or chronic form of the disease. A stress factor may be involved in the precipitation of this disease state. This stress factor may be intercurrent disease such as babesiosis, *Dirofilaria immitus* infection, distemper, liver disease or exposure and excitement of a dog show or some other form of physical stress.

Haematologically, the experimentally infected dogs showed mild, transient decreases in erythrocytes, leucocytes and thrombocytes which occurred independently and at different stages of the infection. One progressed to a persistent pancytopenia and death. These haematological changes also resembled the pattern of many naturally occurring cases, individual cell types were also frequently decreased with pancytopenia being the exception. Bone marrow hypoplasia was evident in some of the naturally occurring cases with pancytopenia. Bone marrow aspirates were not examined from any of these eight experimentally infected dogs. However, it is likely that the bone marrow of the seven dogs may have been unaffected or only mildly so by *E. canis* as they were able to compensate for the erythrocyte, leucocyte or thrombocyte losses. It is likely also that the bone marrow of experimental case 16757 did not regenerate the cells that were decreased in the peripheral blood. The three cell types consequently decreased until death on Day 79 post infection. Post mortem findings of enlarged lymph nodes, wide-spread petechial and ecchymotic haemorrhages and plasma cell infiltration were consistent in this case with ehrlichiosis.

The clinical and haematological findings in these experimentally infected cross-bred dogs resembled the findings of Huxsoll *et al.* (1972) who reported that experimentally infected Beagles and cross-bred dogs recovered from the disease but remained infected. However, they found that experimentally infected German Shepherd dogs developed disease that was indistinguishable from the natural disease, where they often developed a severe haemorrhagic syndrome 60 or more days after the initial infection (Huxsoll, 1975). Huxsoll (1976) therefore associated the severe chronic form with differences in the breed of the dog and not with strain differences of *E. canis*. In this study, the bleeding form of the disease was seen in cross-bred dogs as well as pure-bred dogs in Kenya. The experimentally infected cross-bred dog (Case 16757) and the two year old Irish Setter (Case 19002) both revealed pancytopenia, positive cell culture tests for *E. canis* and post mortem findings which were consistent with a diagnosis of ehrlichiosis. Walker *et al.* (1970) and Huxsoll *et al.* (1970b, 1972) reported that acute and chronic epistaxis were followed by death. Dogs with acute epistaxis usually died within two to five days while those with chronic disease could have mild intermittent epistaxis for approximately three months before death (Walker *et al.*, 1970). In contrast to this report, three naturally occurring cases reported in this study developed epistaxis but did not die. Case 18513 was a three year old Weimeraner which suddenly developed epistaxis and haemorrhages on the skin of the abdomen

and in the eye. The dog responded to treatment with tetracycline hydrochloride. Case 18594 was a two year old German Shepherd dog which had suffered a prolonged episode of epistaxis. This dog was found to harbour both *E. canis* and *B. canis* organisms and responded well to treatment with tetracycline hydrochloride and phenamidine isethionate solution. Case 16049 was a six year old German Shepherd dog which also suffered from epistaxis due to *E. canis* infection. Her peripheral blood was pancytopenic and her bone marrow was hypoplastic. However, she responded to treatment with Gloxazone and tetracycline hydrochloride. Thereafter, although she suffered from repeated bouts of clinical ehrlichiosis, she did not have another episode of epistaxis.

Thus it can be seen that the disease pattern of ehrlichiosis in Kenya differs in some respects from that reported elsewhere in the world.

In addition to improving diagnosis, the cell culture test had provided a means of assessing the ability of drugs to eliminate *E. canis* from infected dogs. Naturally infected cases showing clinical signs of ehrlichiosis presented at the clinic were treated with different dose levels of tetracycline hydrochloride, with doxycycline or with imidocarb dipropionate. The clinical progress of these cases was followed and the ability of the drugs to eliminate *E. canis* was monitored. There was little difference in the clinical response to treatment between the three drugs tested in this study, however their ability to clear *E. canis* was different. Tetracycline

hydrochloride achieved an overall clearance of infection in 25% and doxycycline in 30% of the cases. Imidocarb dipropionate eliminated *E. canis* from 81% of the infected dogs. However, each drug had its own place in treatment, depending on the individual circumstances of the case. The use of oral tetracycline hydrochloride occasionally caused vomiting at the high dose level (66 mg per kg), however, it had fewer noticeable side effects than the use of intramuscular imidocarb dipropionate. It was mandatory that care was exercised in treating old and very sick dogs with imidocarb dipropionate because of the side effects. Doxycycline was a better drug to use in dogs with kidney disease since the drug was better tolerated by uraemic patients. Imidocarb dipropionate given by two intramuscular injections was a more reliable method of ensuring that the patient received the correct medication.

In ehrlichiosis-endemic countries such as Kenya, is it justifiable to use a drug that completely eliminates *E. canis* or should treatment leave the organism in the body to give some form of immune stimulus to the dog? This question can only be answered when the actual effect of *E. canis* on the immune mechanism of the dog is known. Until then, it is probably better to remove the parasite completely so that various stress factors cannot precipitate clinical disease or allow progression to the chronic irreversible disease.

The clinical signs of canine ehrlichiosis and canine babesiosis were very similar and the two infections frequently

occurred together. The only method of differentiation was to search Giemsa - stained peripheral blood smears, where the *Babesia* organisms were usually but not always readily detected whilst *E. canis* bodies were very rarely seen. It was safer therefore to use a drug such as imidocarb dipropionate in these disease situations.

Wild canids including the silver-backed jackal (Neitz and Thomas, 1938) have been experimentally infected with *E. canis*. This study has identified the presence of natural infection with *E. canis* in free-living silver-backed jackals in Kenya. Clinical disease was not evident in these jackals and infection was only identified by *in vitro* culture. However, when the cells from this culture were inoculated into susceptible puppies, they produced a mild, transient disease which was similar to that seen in cross-bred puppies infected with blood from domestic dogs in the acute phase of ehrlichiosis.

The tick species found on the free-living jackals and on domestic dogs owned by pastoral Masai and Turkana in Narok, Kajiado and Turkana Districts were similar. *Rhipicephalus sanguineus* which was present on both species is the only proven vector of *E. canis* in domestic dogs (Donatien and Lestoquard, 1936a; Groves *et al.*, 1975) and although *E. canis* has now been shown to occur naturally in free-living jackals, the vector has not yet been positively identified. These studies indicate that domestic dogs are susceptible to infection with *E. canis* from naturally infected jackals and since the same tick species were

found on both jackals and pastoral domestic dogs, tick sharing by jackals and pastoral domestic dogs may occur. Thus jackals may act as a reservoir host for *E. canis* in Kenya.

The persistence of infection in healthy free-living animals such as the jackal may result in a change in the character of the disease or perhaps in the antigen nature of the parasite and this may explain why ehrlichiosis behaves somewhat differently in Kenya from that reported elsewhere in the world.

REFERENCES

Adeyanju, J.B. and Aliu, Y.O. 1977. Chemotherapeutic Management of Haematozoan Infections of Dogs : Babesiosis, Ehrlichiosis and Hepatozoonosis. Paper presented at *Niger. Vet. Med. Conf.* Nigeria, 1977.

Amyx, H.L. and Huxsoll, D.L. 1973. Red and Gray Foxes - Potential Reservoir Hosts for *Ehrlichia canis*. *J. Wildl. Dis.* 9: 47-50.

Amyx, H.L., Huxsoll, D.L., Zeiler, D.C. and Hildebrandt, P.K. 1971. Therapeutic and Prophylactic Value of Tetracycline in Dogs Infected with the Agent of Tropical Canine Pancytopenia. *J. Am. Vet. Med. Ass.* 159(11): 1428-1432.

Anon. 1960. *Manual of Histologic and Staining Technics*. 2nd Ed. New York: McGraw-Hill Book Company Inc. pp. 207.

Benjamin, M.M. 1961. *Outline of Veterinary Clinical Pathology*. 2nd Ed. Ames: Iowa State University Press. pp. 186.

Best, J.M.J., Butt, K.M. and Rohrbach, J.A. 1969. Occurrence of *Rhipicephalus sanguineus* in London. *Vet. Rec.* 85: 633.

Bobin, A., Chabassol, C., deBrux, J., Fiehrer, A., Guillot, G., Michel, C. and Pigoury, L. 1962. Syndrome Haemorragique Thrombotique Thrombocytopenique du Chien en Tunisie. *Rev. Path. Gen.* 62: 317-334.

Bool, P.H. 1959. Studies on *Ehrlichia canis* (syn. *Rickettsia canis*). *Acta Trop.* 16: 97-107.

Bool, P.H. and Sütmoller, P. 1957. *Ehrlichia canis* Infections in Dogs on Aruba (Netherlands Antilles). *J. Am. Vet. Med.Ass.* 130: 418-420.

Buckner, R.G. and Ewing, S.A. 1967. Experimental Treatment of Canine Ehrlichiosis and Haemobartonellosis. *J. Am. Vet. Med. Ass.* 150(12): 1524-1530.

Buhles, W.C., Huxsoll, D.L. and Ristic, M. 1974. Tropical Canine Pancytopenia : Clinical, Hematologic, and Serologic Response of Dogs to *Ehrlichia canis* Infection, Tetracycline Therapy, and Challenge Inoculation. *J. infect. Dis.* 130(4): 357-367.

Burghen, G.A., Beisel, W.R., Walker, J.S., Nims, R.M., Huxsoll, D.L. and Hildebrandt, P.K. 1971. Development of Hypergammaglobulinemia in Tropical Canine Pancytopenia. *Am. J. Vet. Res.* 32(5): 749-756.

Carmichael, J. 1939. Rickettsia in Dogs. *Ann. Report Vet. Dept. Uganda.* pp.19-20.

Carmichael, J. and Fiennes, R.N.T.W. 1942. Rickettsia Infection of Dogs. *Vet. Rec.* 54(1): 3-4.

Carter, G.B., Seamer, J. and Snape, T. 1971. Diagnosis of Tropical Canine Pancytopenia (*Ehrlichia canis* Infection) by Immunofluorescence. *Res. Vet. Sci.* 12(4): 318-322.

Cassard, H. 1957. Traitement de la Rickettsiose canine par L'auréomycine. *Revue Elev. Med. Vét. Pays trop.* 10: 369-370.

Coffin, D.L. 1954. Necropsy Procedures for the Dog and Cat. In *Veterinary Necropsy Procedures.* Edited by T.C. Jones and C.A. Gleiser. Philadelphia: J.B. Lipincott Company. pp. 136.

Costa, J.O., Silva, M., Batista, J.A. and Guimaraes, M.P. 1973. *Ehrlichia canis* Infection in Dogs in Belo Horizonte - Brazil. *Arquivos da Escola de Veterinaria Minas Gerais.* 25(2): 199-200.

Danks, W.B.C. 1937. Rickettsia Infection of the Dog. *Ann. Report Vet. Dept. Kenya.* 64-66.

Davidson, D.E., Dill, G.S., Tingpalapong, M., Premabutra, S., Nguen, P.L., Stephenson, E.H. and Ristic, M. 1978. Prophylactic and Therapeutic Use of Tetracycline During an Epizootic of Ehrlichiosis among Military Dogs. *J. Am. Vet. Med. Ass.* 172(6): 697-700.

De Lahunta, A. 1977. *Veterinary Neuroanatomy and Clinical Neurology.* Philadelphia: W.B. Saunders Company. pp. 439.

Donatien, A. and Lestoquard, F. 1935. Existence en Algérie d'une Rickettsia du Chien. *Bull. Soc. Path. exot.* 28: 418-419.

Donatien, A. and Lestoquard, F. 1936a. Existence de la Prémunition dans la Rickettsiose Naturelle ou Expérimentale du Chien. *Bull. Soc. Path. exot.* 29: 378-383.

Donatien, A. and Lestoquard, F. 1936b. Recherches sur *Rickettsia canis* Comparison avec *Rickettsia conori*. *Bull. Soc. Path. exot.* 29: 1052-1056.

Donatien, A. and Lestoquard, F. 1937. Etat actuel des Connaissances sur les Rickettsioses Animales. *Archs. Inst. Pasteur Algér.* 15: 142-187.

Donatien, A. and Lestoquard, F. 1940. Du Cycle évolutif de quelques *Rickettsia*. *Archs. Inst. Pasteur Algér.* 18: 203-213.

Dorst, J. and Dandelot, P. 1970. *A Field Guide to the Larger Mammals of Africa*. p.94. London: Collins.

Durand, P. 1932. Le Chien Reservoir de la "Fièvre boutonneuse". *Vet. Bull.* 3: 360-361.

Ellett, E.W., Playter, R.F. and Pierce, K.R. 1974. Retinal Lesions Associated with Induced Canine Ehrlichiosis : A Preliminary Report. *Pract. Vet.* 46(3): 4-7.

Eugster, R.O. 1978. A Contribution to the Epidemiology of Echinococcosis/Hydatidosis in Kenya (East Africa) with special Reference to Kajiado District. Ph.D. Thesis. University of Zurich. Switzerland.

Ewing, S.A. 1936. Observations on Leukocytic Inclusion Bodies from Dogs infected with *Babesia canis*. *J. Am. Vet. Med. Ass.* 143(5): 503-506.

Ewing, S.A. 1964. Correspondence. *J. Am. Vet. Med. Ass.* 144: 4.

Ewing, S.A. 1969. Canine Ehrlichiosis. *Adv. Vet. Sci. Comp. Med.* 13: 331-353.

Ewing, S.A. and Buckner, R.G. 1965. Observations on the Incubation Period and Persistence of *Ehrlichia* sp. in Experimentally Infected Dogs. *Vet. Med. Small Anim. Clin.* 60: 152-155.

Ewing, S.A., Buckner, R.G. and Stringer, B.G. 1964. The Coyote, A Potential Host for *Babesia canis* and *Ehrlichia* sp. *J. Parasit.* 50(5): 704.

Ewing, S.A. and Philip, C.B. 1966. *Ehrlichia*-like Rickettsiosis in Dogs in Oklahoma and its Relationship to *Neorickettsia helminthoeca*. *Am. J. Vet. Res.* 27(116): 67-69.

Ewing,S.A., Roberson, W.R., Buckner, R.G. and Hayat, C.S. 1971. A New Strain of *Ehrlichia canis*. *J. Am. Vet. Med. Ass.* 159(12): 1771-1774.

Gillain, J. 1942. Presence de *Rickettsia canis* au Congo Belge. *Bull. agric. Congo belge.* 33: 106-107.

Gothe, R. and Lämmler, G. 1971. *Aegyptianella pullorum* Infection in the Fowl, a Model for Quantitative Evaluation of the Therapeutic and Prophylactic Efficacy of Tetracyclines. *Vet. Bull.* 41: 206.

Groves, M.G., Dennis, G.L., Amyx, H.L. and Huxsoll, D.L. 1975. Transmission of *Ehrlichia canis* to Dogs by Ticks (*Rhipicephalus sanguineus*). *Am. J. Vet. Res.* 36(7): 937-940.

Haig, D.A. 1955. Tickborne Rickettsioses in South Africa. *Adv. Vet. Sci.* 2: 307-325.

Harvey, J.W., Simpson, C.F., Gaskin, J.M. and Sameck J.H. 1979. Ehrlichiosis in Wolves, Dogs, and Wolf-Dog Crosses. *J. Am. Vet. Med. Ass.* 175(9): 901-905.

Hawkey, C.M. 1975. *Comparative Mammalian Haematology (Cellular Components and Blood Coagulation of Captive Wild Animals).* London: William Heinemann Medical Books Ltd.

Hayat, C.S. 1972.. Pathogenesis of two Isolates of *Ehrlichia canis* in Dogs. *Dissertation Abstracts Int.* 33B(12): 6135-6136.

Hayat, C.S. 1973a. *Ehrlichia canis* as a cause of Thrombocytopenia in Dogs. *Pakist. J.scient. Res.* 25: 193-196.

Hayat, C.S. 1973b. Morulae of *Ehrlichia canis* in the Nucleus of Lymphocytes. *Pakist. J. scient. Res.* 25: 214.

Hayat, C.S. and Ewing, S.A. 1973. A Comparison of Incubation Period and Persistence of 2 strains of *Ehrlichia canis* in Dogs. *Pakist. J. scient. Res.* 25: 271-273.

Henning, M.W. 1948. *Animal Diseases in South Africa.* 2nd. Ed. Johannesburg: Central News Agency Ltd. pp. 842-848.

Hildebrandt, P.K., Conroy, J.D., McKee, A.E., Nyindo, M.B.A. and Huxsoll, D.L. 1973a. Ultrastructure of *Ehrlichia canis*. *Infect. Immunity.* 7(2): 265-271.

Hildebrandt, P.K., Huxsoll, D.L., Walker, J.S., Nims, R.M., Taylor, R. and Andrews, M. 1973b. Pathology of Canine Ehrlichiosis (Tropical Canine Pancytopenia). *Am. J. Vet. Res.* 34(10): 1309-1320.

Huxsoll, D.L. 1975. Tropical Canine Pancytopenia. 20th World Vet. Congress. Thessaloniki. Greece. Summaries, Vol.1:264-265.

Huxsoll, D.L. 1976. Canine Ehrlichiosis (Tropical Canine Pancytopenia) : A Review. *Vet. Parasit.* 2: 49-60.

Huxsoll, D.L., Amyx, H.L., Hemelt, I.E., Hildebrandt, P.K., Nims, R.M. and Gochenour, W.S. 1972. Laboratory Studies of Tropical Canine Pancytopenia. *Expt. Parasit.* 31: 53- 59.

Huxsoll, D.L., Hildebrandt, P.K., Nims, R.M., Amyx, H.L. and Ferguson, J.A. 1970a. Epizootiology of Tropical Canine Pancytopenia. *J. Wildl. Dis.* 6: 220-225.

Huxsoll, D.L., Hildebrandt, P.K., Nims, R.M., Ferguson, J.A. and Walker, J.S. 1969. Letter: *Ehrlichia canis* - The causative Agent of a Haemorrhagic Disease of Dogs? *Vet. Rec.* 85: 587.

Huxsoll, D.L., Hildebrandt, P.K., Nims, R.M. and Walker, J.S. 1970b. Tropical Canine Pancytopenia. *J. Am. Vet. Med. Ass.* 157(11): 1627-1632.

Immelman, A. 1977. Blood levels of Oxytetracycline in Dogs after Oral Administration. *J. S. Afr. Vet. Ass.*48(3): 183-186.

Immelman, A. and Button, C. 1973. *Ehrlichia canis* Infection (Tropical Canine Pancytopenia or Canine Rickettsiosis). *J. S. Afr. Vet.Ass.* 44(3): 241-245.

Kakoma, I., Carson, C.A., Ristic, M., Huxsoll, D.L., Stephenson, E.H. and Nyindo, M.B.A. 1977. Autologous Lymphocyte - Mediated Cytotoxicity Against Monocytes in Canine Ehrlichiosis. *Am. J. Vet. Res.* 38(10): 1557-1559.

Kaminjolo, J.S., Nyindo, M.B.A., Sayer, P.D., Rurangirwa, F., Johnson, L.W., Hird, S.F., Rosenbaum, E., Maxie, L.L.S. and Ogaa, J.S. 1976. Identification of *Ehrlichia canis* in East Africa. *Vet. Rec.* 99:434-435.

Khera, S.S. 1962. Rickettsial Infections in Animals : A Review. *Indian J. Vet. Sci.* 32: 283-301.

King, E.J. and Armstrong, A.R. 1934. *Can. med. Ass. J.* 31: 376.

Kirk, R. 1977. *Current Veterinary Therapy Vl.* Philadelphia: Saunders Company. pp. 1418.

Klopfer, U. and Nobel, T.A. 1972. Canine Ehrlichiosis (Tropical Canine Pancytopenia) in Israel. *Refuah vet.* 29(1): 24-29.

Krause, D.W., Perine, P.L., McDade, J.E. and Awoke, S. 1975. Treatment of Louse-borne Typhus Fever with Chloramphenicol, Tetracycline or Doxycycline. *E. A. Med. J.* 52(8): 422-427.

Lawrence, D.A. 1938. Rickettsiosis in a Dog. *J. S. Afr. Vet. Med. Ass.* 9(4): 175-178.

Lawrence, J.A. and Efstratiou, S. 1973. Canine Ehrlichiosis in Rhodesia. *Rhod. Vet. J.* 3: 55-57.

Leeflang, P. 1970. Studies on *Ehrlichia canis*. *J. Parasit.* 56: 203-204.

Leeflang, P. 1971.. Letter; Relation Between Carrier-state Oxytetracycline Administration and Immunity in *Ehrlichia canis* Infections. *Vet. Rec.* 90: 703-704.

Leeflang, P. and Perie, N.M. 1972. A Comparative Study of the Pathogenicities of Old and New World Strains of *Ehrlichia canis*. *Trop. Anim. Hlth. Prod.* 4: 107-108.

Leibowitz, B.J., Hakes, J.L., Cahn, M.M. and Levy, E.J. 1972. Doxycycline Blood Levels in Normal Subjects after Intravenous and Oral Administration. *Current Therapeutic Research.* 14: 820-831.

Lewis, G.E. 1975. Equine Ehrlichiosis. 20th World. Vet. Congress. Thessaloniki, Greece. Summaries, Vol.1: 265-266.

Lewis, G.E. 1976. Equine Ehrlichiosis : A Comparison between *E. equi* and other Pathogenic Species of *Ehrlichia*. *Vet. Parasit.* 2: 61-74.

Lewis, G.E. 1977. The Effect of Serum Macrophages Derived from *Ehrlichia canis*-immune Dogs on the *in vitro* Growth and Development of *Ehrlichia canis*. *Dissertation Abstracts Int.* 38(6): 2544B.

Lewis, G.E., Ristic, M., Smith, R.D., Lincoln, T. and Stephenson, E.H. 1977. The Brown Dog Tick, *Rhipicephalus sanguineus* and the Dog as Experimental Hosts of *Ehrlichia canis*. *Am. J. Vet. Res.* 38(12): 1953-1955.

Malbrant, R. 1939. Rickettsiose canine au Congo Francais. *Bull. Soc. Path. exot.* 32: 908-913.

Malbrant, R. 1945. Conjonctivite Rickettsienne du Chien au Congo Francais. *Bull. Soc. Path. exot.* 38: 251-252.

Malherbe, W.D. 1947. *Rickettsia canis* Infection in Dogs in the Pretoria District. *S. Afr. J. Sci.* 43: 271-276.

Malherbe, W.D. 1948. The Diagnosis and Treatment of Rickettsiosis in Dogs. *J. S. Afr. Vet. Med. Ass.* 19: 135-138.

Meyer, L.M. and Bloom, F. 1943. The Bone Marrow of Normal Dogs. *Am. J. Med. Sci.* 206: 637.

Moshkovskii, S.D. 1945. Cytotropic Inducers of Infection and the Place of the Rickettsias in the Chlamydozoa system. *Usp. sovrem. Biol.* 19: 1-44.

Mudaliar, S.V. 1944. Canine Rickettsioses in South India - A Preliminary Note. *Indian Vet. J.* 20: 163-164.

Murray, M. 1967. The Pathology of some Diseases Found in Wild Animals in East Africa. *E. A. Wildl. J.* 5: 37-45.

Murray, M. 1968. A Survey of Diseases found in Dogs in Kenya. *Bull. Epizoot. Dis. Afr.* 16: 121-127.

McGaughey, C.A., Seneviratna, P. and Mahalingam, S. 1962. Rickettsiosis of Dogs in Ceylon. *Ceylon vet. J.* 10(2): 82-87.

Neitz, W.O. 1939. The Appearance of *Bartonella canis* in a Dog Suffering from *Rickettsia canis*. *J.S. Afr. Vet. Med. Ass.* 10(3): 103-105.

Neitz, W.O. 1967. The Epidemiological Pattern of Viral, Protophytal and Protozoal Zoonoses in Relation to Game Preservation in South Africa. *J.S. Afr. Vet. Med. Ass.* 38(2): 129-141.

Neitz, W.O. and Thomas, A.D. 1938. Rickettsiosis in the Dog. *J. S. Afr. Med. Ass.* 9: 166-174.

Nims, R.M., Ferguson, J.A., Walker, J.L., Hildebrandt, P.K., Huxsoll, D.L., Reardon, M.J., Varley, J.E., Kolaja, G.J., Watson, W.T., Shrover, E.L., Elwell, P.A. and Vacura, G.W. 1971. Epizootiology of Tropical Canine Pancytopenia in Southeast Asia. *J. Am. Vet. Med. Ass.* 158(1): 53-63.

Noble, N.M. 1973. Tropical Canine Disease Poses Risk. *Anim. Quarantine.* 2: 1-3.

Nyindo, M.B.A., Ristic, M., Huxsoll, D.L. and Smith, A.R. 1971. Tropical Canine Pancytopenia : *in vitro* cultivation of the causative Agent - *Ehrlichia canis*. *Am. J. Vet. Res.* 32(11): 1651-1658.

Nyindo, M.B.A., Ristic, M., Lewis, G.E., Huxsoll, D.L. and Stephenson, E.H. 1978. Immune Response of Ponies to Experimental Infection with *Ehrlichia equi*. *Am. J. Vet. Res.* 39(1): 15-18.

Pasquini. 1941. Treatment of Canine Rickettsiasis by Intravenous Injections of Formolized Physiological Saline. *Vet. Bull.* 11: 556-557.

Philip, C.B. 1959. Canine Rickettsiosis in Western United States and Comparison with a Similar Disease in the Old World. *Archs. Inst. Pasteur Tunis.* 36: 595-603.

Philip, C.B. 1974. *Bergey's Manual of Determinative Bacteriology.* 8th Ed. Buchanan, R.E. and Gibbons, N.E. editors. Baltimore: Williams and Wilkins. pp. 893-897.

Pierce, K.R. 1971. *Ehrlichia canis* ; A cause of Pancytopenia in Dogs in Texas. *S. West. Vet.* 24: 236-267.

Pierce, K.R., Marrs, G.E. and Hightower, D. 1977. Acute Canine Ehrlichiosis : Platelet survival and Factor 3 Assay. *Am. J. Vet. Res.* 38(11): 1821-1825.

Raghavachari, K. and Reddy, A.M.K. 1958. *Rickettsia canis* in Hyderabad. *Indian Vet. J.* 35: 63-68.

Receveur, P and Hugaud, G. 1949. Existence de *Rickettsia canis* au Tchad. *Revue Elev. Méd. Vét. Pays trop.* 3: 45.

Reitman, S. and Frankel, S 1957. *Am. J. clin. Path.* 28: 56.

Robinson, F.R. and Garner, F.M. 1973. Histopathologic Survey of 2 500 German Shepherd Military Working Dogs. *Am. J. Vet. Res.* 34(3): 437-442.

Ristic, M. 1978. In *Tick-borne Diseases and their vectors.* Edited by J.H.K. Wilde. University of Edinburgh: Centre for Tropical Veterinary Medicine. pp. 475-481

Ristic, M. and Carson, C.A. 1978. In *Tick-borne Diseases and their vectors.* Edited by J.H.K. Wilde. University of Edinburgh: Centre for Tropical Veterinary Medicine. pp. 523-526.

Ristic, M., Huxsoll, D.L., Weisiger, R.M., Hildebrandt, P.K. and Nyindo, M.B.A. 1972. Serological Diagnosis of Tropical Canine Pancytopenia by Indirect Immunofluorescence. *Infect. Immunity.* 6(3): 226-231.

Saror, D.I. and Pimentel, W.J. 1972. Clinical Aspects of Tropical Canine Pancytopenia. *Niger. Vet. J.* 1(1): 16-18.

Schalm, O.W., Jain, N.C. and Carroll, E.J. 1975. *Veterinary Haematology,* 3rd. Ed. Philadelphia: Lea and Febiger. pp. 807.

Scott, G.R. 1978. In *Tick-borne Diseases and their Vectors.* Edited by J.H.K. Wilde. University of Edinburgh: Centre for Tropical Veterinary Medicine. pp. 451-473.

Seamer, J. and Snape, T. 1970. Letter; Tropical Canine Pancytopenia and *Ehrlichia canis* Infection. *Vet. Rec.* 86: 375.

Seamer, J. and Snape, T. 1972. *Ehrlichia canis* and Tropical Canine Pancytopenia. *Res. Vet. Sci.* 13(4): 307-314.

Shirlaw, J.F. 1938. On the Relationship between "Lahore Canine Fever" and "Tick Fever" of Dogs due to *P. gibsoni* Infection with Observations on their Pathology and Haemocytology. *Indian J. Vet. Sci.* 8: 293-316.

Simpson, R.V. 1972a. Canine Ehrlichiosis - A Contrast of the Domestic Disease and Tropical Canine Pancytopenia. *S. West. Vet.* 26(1): 31-33.

Simpson, C.F. 1972b. Structure of *Ehrlichia canis* in Blood Monocytes of a Dog. *Am. J. Vet. Res.* 33(12): 2451-2454.

Simpson, C.F. 1974. Relationship of *Ehrlichia canis*-Infected Mononuclear Cells to Blood Vessels of Lungs. *Infection and Immunity.* 10(3): 590-596.

Smith, R.D., Hooks, J.E., Huxsoll, D.L. and Ristic, M. 1974. Canine Ehrlichiosis (Tropical Canine Pancytopenia) : Survival of Phosphorus-32-Labeled Blood Platelets in Normal and Infected Dogs. *Am. J. Vet. Res.* 35(2): 269-273.

Smith, R.D., Ristic, M., Huxsoll, D.L. and Baylor, R.A. 1975. Platelet Kinetics in Canine Ehrlichiosis : Evidence for Increased Platelet Destruction as the Cause of Thrombocytopenia. *Infection and Immunity.* 11(6): 1216-1221.

Smith, R.D., Sells, D.M., Lewis, G.E. and Ristic, M. 1978. In *Tick-borne Diseases and their Vectors.* Edited by J.H.K. Wilde. University of Edinburgh; Centre for Tropical Veterinary Medicine. pp. 517-518.

Smith, R.D., Sells, D.M., Stephenson, E.H., Ristic, M. and Huxsoll, D.L. 1976 Development of *Ehrlichia canis*, Causative Agent of Canine Ehrlichiosis, in the Tick *Rhipicephalus sanguineus* and its Differentiation from a Symbiotic Rickettsia. *Am. J. Vet. Res.* 37: 119-126.

Smith, R.D., Small, E., Weisiger, R., Byerly, C.S. and Ristic, M. 1975. Isolation in Illinois of a Foreign Strain of *Ehrlichia canis*, the Causative Agent of Canine Ehrlichiosis (Tropical Canine Pancytopenia). *J. Am. Vet. Med. Ass.* 166(2): 172-174.

Snyder, J.C. 1967. Rickettsial Diseases. In *Textbook of Medicine*. 12th Ed. London: W.B. Saunders Company.

Spence, J.B., Giam, C.H. and Theis, J.H. 1967. A New Canine Disease Syndrome. *Vet. Rec.* 81: 328-329.

Stephenson, E.H., Clothier, E.R. and Ristic, M. 1975. *Ehrlichia canis* Infection in a Dog in Virginia. *J. Am. Vet. Med. Ass.* 167(1): 71-72.

Stephenson, E.H. and Osterman, J.V. 1977. Canine Peritoneal Macrophages : Cultivation and Infection with *Ehrlichia canis*. *Am. J. Vet. Res.* 38(11): 1815-1819.

Stephenson, E.H. and Ristic, M. 1978. Retrospective Study of an *Ehrlichia canis* Epizootic Around Phoenix, Arizona. *J. Am. Vet. Med. Ass.* 172(1): 63-65.

Sütmoller, P. 1964. Correspondence; Leukocytic Inclusion Bodies. *J. Am. Vet. Med. Ass.* 144: 4.

Taussky, H.H. and Shorr, E. 1953. A Microcolourimetric Method for the Determination of Inorganic Phosphorus. *J. biol. Chem.* 202: 675-685.

Varley, H. 1969. *Biuret Method.* London: William Heinemann - Medical Books.

van Dijk, J.E. 1971. Studies on *Ehrlichia canis*. *Zentbl. Vet. Med.* 18 B: 787-803.

Wakelin, D. 1978. Immunity to Intestinal Parasites. *Nature Wash.* 273: 617-620.

Walker, J.B. 1974. *The Ixodid Ticks of Kenya.* London: Commonwealth Institute of Entomology.

Walker, J.S., Rundquist, J.D., Taylor, R., Wilson, B.L., Andrews, M.R., Barck, J., Hogge, A.L., Huxsoll, D.L., Hildebrandt, P.K. and Nims, R.M. 1970. Clinical and Clinicopathologic Findings in Tropical Canine Pancytopenia. *J. Am. Vet. Med. Ass.* 157:(1): 43-55.

Webster, W.W. 1962. *Am. J. clin. Path.* 37: 330-333.

Weisiger, R.M., Ristic, M. and Huxsoll, D.L. 1975 Kinetics of Antibody Response to *Ehrlichia canis* Assayed by the Indirect Fluorescent Antibody Method. *Am. J. Vet. Res.* 36(5): 689-694.

Wilkins, J.H., Bowden, R.S.T. and Wilkinson, R.T. 1967. A New Canine Disease Syndrome. *Vet. Rec.* 81: 57-58.

Willder, A.G. 1977. Prophylactic use of Tetracycline for Tropical Canine Pancytopenia. *Vet. Rec.* 101: 5.

APPENDIX

APPENDIX TABLE : A 1

HAEMATOLOGY AND SERUM BIOCHEMISTRY OF EXPERIMENTAL CASE 16748

PARAMETER	Days. 1977	-72 6/1	-38 9/2	-30 17/2	-5 14/3	0 19/3	4 23/3	6 25/3	9 28/3	10 29/3	11 30/3	12 31/3	13 1/4	16 4/4
Packed cell volume (%)		41	44	44	47	46	45	45	46	48.8	48	43	50	46
Haemoglobin (g/100 ml)		13.5	14.8	13.8	15.5	14.8	14.3	14.6	15.4	14.5	15.4	15.9	15.6	16.5
Erythrocytes X $10^6/mm^3$		4.92	6.06	6.39	6.21	6.04	5.77	5.94	6.48	5.93	6.30	6.20	6.42	6.22
Nucleated erythrocytes (%)														
Platelets X $10^3/mm^3$		125	598	340	501	463	N	212	-	-	-	242	-	-
Leucocytes X $10^3/mm^3$		10.3	14.0	19.9	12.8	14.0	17.8	13.6	13.9	14.7	10.7	15.4	16.1	13.0
Neutrophils (%)		57	46	49	54	47	55	54	56	62	57	23	51	67
Lymphocytes (%)		38	41	42	39	47	42	36	43	37	42	66	44	31
Monocytes (%)		0	0	2	1	0	1	2	2	1	0	0	0	0
Eosinophils (%)		6	13	8	6	6	2	8	1	0	1	1	5	2
Mean cell volume (μm^3)		63	69	68	73	76	73	73	70	80	76	71	77	81
Mean cell haemoglobin concentration (%)		33.0	33.6	31.4	33.0	32.2		32.4	33.5	30.1	32.2	36.0	31.2	35.4
Urea nitrogen (mg/100 ml)		30	20	30	30	20	20	20	30	-	20	-	-	-
Phosphorus (mg/100 ml)		7.40	6.45	10.02	7.40	7.00	8.05	8.40	6.84		-			
Alkaline phosphatase (King Armstrong units)		11.20	5.70	10.52	8.65	8.85	9.15	8.56	8.85		-			
Serum glutamic phosphoric transaminase (Reitman Frankel units)														
Total protein (g/100 ml)		4.90	5.60	5.60	5.65	5.45	5.50	4.90	5.15		6.00			
Albumin (g/100 ml)		3.10	3.75	3.65	4.10	3.85	3.85	3.59	3.65		4.10			
Globulin (g/100ml)		1.80	1.85	1.95	1.55	1.60	1.65	1.31	1.50		1.90			
Albumin/Globulin ratio		1.72	2.05	1.87	2.64	2.41	2.34	2.74	2.43		2.16			

PARAMETER	Days 1977	18 6/4	19 7/4	22 10/4	24 12/4
Packed cell volume (%)		45	45	43	42
Haemoglobin (g/100 ml)		15.0	15.1	13.0	14.5
Erythrocytes X $10^6/mm^3$		6.06	6.10	5.42	5.94
Nucleated erythrocytes (%)					1
Platelets X $10^3/mm^3$		324	-	N	<N
Leucocytes X $10^3/mm^3$		10.3	11.5	9.9	11.6
Neutrophils (%)		54	47	65	43
Lymphocytes (%)		40	47	31	54
Monocytes (%)		1	0	0	0
Eosinophils (%)		5	6	4	3
Mean cell volume (μm^3)		67	69	68	70
Mean cell haemoglobin concentration (%)		33.3	33.3	30.2	34.6
Urea nitrogen (mg/100 ml)		15			
Phosphorus (mg/100 ml)		6.25			
Alkaline phosphatase (King Armstrong units)		7.50			
Serum glutamic phosphoric transaminase (Reitman Frankel units)					
Total protein (g/100 ml)		5.25			
Albumin (g/100 ml)		3.75			
Globulin (g/100 ml)		1.50			
Albumin/Globulin ratio		2.50			

APPENDIX TABLE : A 1 (continued)

26	30	32	37	39	41	45	47	51
14/4	18/4	20/4	25/4	27/4	29/4	3/5	5/5	9/5
42	44	38	44	43	45	48	46	48
14.8	14.6	13.6	14.7	14.2	14.4	16.4	15.9	15.5
6.02	6.23	5.21	6.08	5.94	6.32	6.69	5.46	5.82
				10				
168	-	198	-	510	N	179	182	278
12.3	11.7	11.4	9.8	11.5	14.4	14.8	11.3	13.7
35	56	37	51	55	48	41	58	42
63	39	61	43	34	50	54	39	52
0	1	0	3	6	0	0	0	0
2	4	2	4	5	2	5	3	6
69	68	69	69	68	71	68	67	68
35.2	33.2	35.4	33.6	33.0	33.0	34.2	34.6	32.2
	25		30				30	
	7.50		8.80				5.83	
	7.55		7.20				7.45	
	5.40		7.00				5.10	
	3.40		2.80				3.50	
	2.00		4.20				1.60	
	1.70		0.67				2.18	

PARAMETER	Days 1977	53 11/5	55 13/5	60 18/5	66 24/5
Packed cell volume (%)		49	49	49	48.5
Haemoglobin (g/100 ml)		15.6	15.9	14.1	15.9
Erythrocytes X $10^6/mm^3$		6.52	6.47	6.77	6.39
Nucleated erythrocytes (%)					
Platelets X $10^3/mm^3$		-	-	224	-
Leucocytes X $10^3/mm^3$		11.9	11.6	11.9	10.9
Neutrophils (%)		44		54	47
Lymphocytes (%)		50		36	50
Monocytes (%)		0		2	1
Eosinophils (%)		6		8	2
Mean cell volume (μm^3)		67	66	65	65
Mean cell haemoglobin concentration (%)		31.8	33.2	32.5	32.8
Urea nitrogen (mg/100 ml)			10	25	
Phosphorus (mg/100 ml)			6.40	3.30	
Alkaline phosphatase (King Armstrong units)			11.60	12.80	
Serum glutamic phosphoric transaminase (Reitman Frankel units)					
Total protein (g/100 ml)			5.50	5.25	
Albumin (g/100 ml)			3,42	3.75	
Globulin (g/100 ml)			2.08	1.50	
Albumin/Globulin ratio			1.64	2.50	

APPENDIX TABLE : A 1 (continued)

69	73	76	80	81	83	87	90	94
27/5	31/5	3/6	7/6	8/6	10/6	14/6	17/6	21/6
48	49	50	44.5	45	43	41	46	47
14.6	16.2	15.8	15.4	15.1	14.5	13.8	15.6	15.6
6.31	6.73	6.63	6.83	6.69	6.30	5.94	6.73	6.67
112	-	124	-	168	-	-	128	-
12.4	11.4	9.1	11.9	10.3	11.7	11.6	11.0	11.8
44	50	52	54	42	49	50	57	50
40	38	43	38	50	44	46	38	39
0	0	0	0	1	0	0	0	0
16	12	5	8	7	7	4	5	11
75	65	63	65	71	67	67	70	66
30.4	33.1	31.6	34.6	33.6	33.8	33.7	34.0	33.1
20			20				30	
4.60			6.00				7.50	
7.50			9.45				11.40	
4.70			4.90				5.40	
2.75			3.10				3.40	
1.95			1.80				2.00	
1.41			1.72				1.70	

PARAMETER	Days 1977	96 23/6	101 28/6	108 5/7	118 15/7
Packed cell volume (%)		54.0	48.5	44.9	59.0
Haemoglobin (g/100 ml)		18.6	16.3	15.3	15.9
Erythrocytes X $10^6/mm^3$		6.08	7.14	6.59	6.70
Nucleated erythrocytes (%)					
Platelets X $10^3/mm^3$		176	182	161	-
Leucocytes X $10^3/mm^3$		13.6	12.2	12.4	11.1
Neutrophils (%)		48	65	50	53
Lymphocytes (%)		39	23	45	40
Monocytes (%)		0	0	0	0
Eosinophils (%)		13	12	5	7
Mean cell volume (μm^3)		66	65	64	67
Mean cell haemoglobin concentration (%)		33.4	33.6	31.2	36.6
Urea nitrogen (mg/100 ml)			20	15	
Phosphorus (mg/100 ml)			4.35	9.15	
Alkaline phosphatase (King Armstrong units)			11.40	13.30	
Serum glutamic phosphoric transaminase (Reitman Frankel units)					
Total protein (g/100 ml)			5.10	5.10	
Albumin (g/100 ml)			3.25	4.10	
Globulin (g/100 ml)			1.85	1.00	
Albumin/Globulin ratio			1.76	4.10	

APPENDIX TABLE : A 1 (continued)

122	125	129	132	137	139	143	146	151
19/7	22/7	26/7	29/7	3/8	5/8	9/8	12/8	17/8
45.0	53.0	42.0	43.0	44.0	48.5	39.0	45.0	38.0
16.1	17.0	14.5	14.8	15.5	15.1	13.5	14.6	13.4
6.73	7.46	6.27	6.32	6.59	6.23	5.95	6.53	5.90
-	132	160	-	297	-	-	154	-
13.1	15.8	12.4	12.5	13.0	12.2	12.5	12.1	9.8
59	49	68	65	64	57	65	58	61
32	35	25	27	30	32	28	29	30
0	0	0	0	1	1	0	3	4
9	6	7	8	5	10	7	10	5
69	70	68	68	70	70	69	70	69
35.8	32.0	34.5	34.2	35.2	31.2	34.6	32.5	35.2
				5.90		4.80		
				7.95		10.00		
				5.75		5.50		
				3.45		3.20		
				2.30		2.30		
				1.50		1.39		

APPENDIX TABLE

PARAMETER	Days 1977	156 22/8	157 23/8	164 30/8	172 7/9	174 9/9	209 14/10
Packed cell volume (%)		45		44	39	43	47
Haemoglobin (g/100 ml)		13.6		14.1	13.2	14.0	15.6
Erythrocytes X $10^6/mm^3$		5.63		6.18	5.84	6.07	6.34
Nucleated erythrocytes (%)							
Platelets X $10^3/mm^3$		-		-	-	136	407
Leucocytes X $10^3/mm^3$		10.8		12.3	9.2	12.4	9.1
Neutrophils (%)		53		61	60	60	54
Lymphocytes (%)		38		30	32	33	28
Monocytes (%)		0		1	1	0	4
Eosinophils (%)		8		9	7	7	14
Mean cell volume (μm^3)		74		70	71	71	72
Mean cell haemoglobin concentration (%)		34.0		32.0	34.0		33.0
Urea nitrogen (mg/100 ml)			20	20	25		
Phosphorus (mg/100 ml)			4.00	6.20	6.35		
Alkaline phosphatase (King Armstrong units)			10.80	12.30	12.50		
Serum glutamic phosphoric transaminase (Reitman Frankel units)							
Total protein (g/100 ml)			5.40	5.90	5.70		
Albumin (g/100 ml)			3.25	3.40	3.60		
Globulin (g/100 ml)			2.15	2.50	2.10		
Albumin/Globulin ratio			1.51	1.36	1.71		

: A 1 (continued)

212	214	216	220
17/10	19/10	21/10	25/10
44	35	46.5	46
16.0	14.4	16.1	17.1
6.26	5.60	6.17	6.95
452	-	388	320
12.5	10.5	11.3	12.8
62	48	58	61
30	41	34	31
4	2	0	0
4	9	8	8
73	71	75	71
36.0	37.4	35.0	37.0
		15	20
		6.95	6.35
		6.56	6.40
		5.35	6.10
		3.50	3.65
		1.85	2.45
		1.89	1.49

PARAMETER	Days 1977	-72 6/1	-38 9/2	-30 17/2	-5 14/3
Packed cell volume (%)		29	36.5	39	44
Haemoglobin (g/100 ml)		8.6	11.9	12.7	14.3
Erythrocytes X $10^6/mm^3$		3.74	5.59	5.94	6.06
Nucleated erythrocytes (%)					
Platelets X $10^3/mm^3$		152	360	360	413
Leucocytes X $10^3/mm^3$		9.0	12.4	18.8	13.0
Neutrophils (%)		51	60	64	27
Lymphocytes (%)		40	33	32	58
Monocytes (%)		0	1	0	0
Eosinophils (%)		9	6	4	7
Mean cell volume (μm^3)		58	62	64	72
Mean cell haemoglobin concentration (%)			32.6	32.8	32.6
Urea nitrogen (mg/100 ml)		25	15	25	30
Phosphorus (mg/100 ml)		5.37	6.45	9.00	7.30
Alkaline phosphatase (King Armstrong units)		7.40	4.30	8.40	7.20
Serum glutamic phosphoric transaminase (Reitman Frankel units)					
Total protein (g/100 ml)		6.00	6.90	5.95	6.40
Albumin (g/100 ml)		2.15	3.20	3.00	3.15
Globulin (g/100 ml)		3.85	3.70	2.95	2.25
Albumin/Globulin ratio		0.55	0.87	1.02	1.40

APPENDIX TABLE : A 2

SERUM BIOCHEMISTRY OF EXPERIMENTAL CASE 16749

0	4	6	9	10	11	12	13	14
19/3	23/3	25/3	28/3	29/3	30/3	31/3	1/4	4/4
42	44	42	42	49.1	42	44	44	42
12.9	14.0	12.9	13.4	14.5	13.7	14.9	13.4	13.8
5.70	6.36	6.00	6.08	6.64	6.77	6.60	6.03	6.06
440	N	306	-	-	-	278	-	-
13.8	17.3	15.3	13.8	16.2	15.4	18.4	16.3	16.8
57	41	51	29	49	45	49	39	35
34	46	40	63	51	47	47	55	56
0	3	2	0	0	5	1	0	0
9	10	7	8	0	3	3	6	9
73	64	69	78	72	88	66	68	74
30.7		30.7	32.0	30.0	32.6	34.8	30.6	32.8
25	30	35	25		25			
7.00	8.45	7.60	7.05		-			
7.40	8.60	7.83	7.95		-			
6.25	6.25	6.00	6.05		6.58			
3.15	3.15	3.00	3.00		3.35			
3.10	3.10	3.00	3.05		3.23			
1.01	1.03	1.00	0.98		1.04			

PARAMETER	Days 1977	18 6/4	19 7/4	22 10/4	24 12/4
Packed cell volume (%)			44	43	42.5
Haemoglobin (g/100ml)			13.5	13.3	14.4
Erythrocytes X $10^6/mm^3$			5.94	5.62	6.79
Nucleated erythrocytes (%)					
Platelets X $10^3/mm^3$			-	N	<N
Leucocytes X $10^3/mm^3$			12.2	14.0	12.9
Neutrophils (%)			28	41	26
Lymphocytes (%)			70	54	66
Monocytes (%)			0	0	0
Eosinophils (%)			2	5	8
Mean cell volume (μm^3)			65	65	65
Mean cell haemoglobin concentration (%)			30.7	31.0	34.5
Urea nitrogen (mg/100 ml)		20			
Phosphorus (mg/100 ml)		6.85			
Alkaline phosphatase (King Armstrong units)		6.7			
Serum glutamic phosphoric transaminase (Reitman Frankel units)					
Total protein g/100 ml)		6.40			
Albumin (g/100 ml)		3.10			
Globulin (g/100 ml)		3.30			
Albumin/Globulin ratio		0.94			

APPENDIX TABLE : A 2 (continued)

26	30	32	37	39	41	45	47	51
14/4	18/4	20/4	25/4	27/4	29/4	3/5	5/5	9/5
43	45	44	40	45	42	46	40	46
14.7	14.4	14.4	12.8	14.2	14.0	15.1	12.9	14.5
6.36	6.74	6.33	5.84	6.31	6.36	6.80	5.16	5.76
				18				
182	-	210	-	264	-	207	168	202
15.4	14.1	17.0	16.5	13.35	16.0	16.1	15.6	14.7
18	32	25	31	48	39	41	42	28
78	60	66	51	44	57	51	50	64
0	1	0	10	6	0	2	0	0
4	7	9	8	2	4	6	8	8
65	64	65	69	66	65	64	71	63
34.1	32.0	32.8	32.1	31.0	33.3	32.8	32.2	31.5
	25		15				27	
	7.00		12.35				5.95	
	7.05		6.24				7.15	
	6.00		7.40				7.20	
	2.85		2.75				2.90	
	3.15		4.65				2.80	
	0.90		0.59				1.35	

PARAMETER	Days 1977	53 11/5	55 13/5	60 18/5	66 24/5
Packed cell volume (%)		42	46	41	45
Haemoglobin (g/100 ml)		13.3	14.5	13.2	14.6
Erythrocytes X $10^6/mm^3$		6.15	6.30	5.87	6.50
Nucleated erythrocytes (%)					
Platelets X $10^3/mm^3$		-	-	158	-
Leucocytes X $10^3/mm^3$		11.60	14.10	9.90	13.40
Neutrophils (%)		33	32	31	35
Lymphocytes (%)		65	55	55	58
Monocytes (%)		0	4	3	1
Eosinophils (%)		2	9	11	6
Mean cell volume (μm^3)		65	62	63	64
Mean cell haemoglobin concentration (%)		31.35	31.20	36.40	32.50
Urea nitrogen (mg/100 ml)			15	30	
Phosphorus (mg/100 ml)			6.0	4.0	
Alkaline phosphatase (King Armstrong units)			10.50	6.95	
Serum glutamic phosphoric transaminase (Reitman Frankel units)					
Total protein (g/100 ml)			6.10	6.25	
Albumin (g/100 ml)			2.85	2.90	
Globulin (g/100 ml)			3.25	3.35	
Albumin/Globulin ratio			0.88	0.87	

APPENDIX TABLE : A 2 (continued)

69	73	76	80	81	83	85	87	90
27/5	31/5	3/6	7/6	8/6	10/6	12/6	14/6	17/6
43	47	46	46	42	43	45	44	45
11.7	15.4	14.8	14.5	13.9	13.8	13.9	14.7	14.0
6.08	6.68	6.71	6.52	6.50	6.35	6.17	6.65	6.57
178	-	170	-	162	-	221	-	172
11.88	15.50	11.90	12.80	9.80	15.10	11.40	14.40	15.50
34	27	28	56	25	53	32	31	32
61	64	64	38	63	46	58	63	52
0	0	0	0	6	0	0	0	0
5	9	8	6	6	1	10	6	14
64	63	60	64	62	66	66	63	65
30.80	32.80	32.40	31.60	33.10	32.20	30.90	33.40	31.20
20			30					30
4.8			5.6					8.65
7.5			9.2					11.7
5.60			6.70					6.40
2.50			2.75					3.00
3.10			3.95					3.40
0.81			0.70					0.88

PARAMETER	Days 1977	94 21/6	96 23/6	101 28/6	108 5/7
Packed cell volume (%)		45	54	44	39
Haemoglobin (g/100 ml)		15.3	17.9	13.8	13.6
Erythrocytes X $10^6/mm^3$		6.67	6.12	6.15	6.08
Nucleated erythrocytes (%)					
Platelets X $10^3/mm^3$		-	282	202	182
Leucocytes X $10^3/mm^3$		14.6	16.0	15.7	14.9
Neutrophils (%)		31	45	37	36
Lymphocytes (%)		64	40	56	58
Monocytes (%)		0	0	0	0
Eosinophils (%)		5	15	7	6
Mean cell volume (μm^3)		64	65	65	65
Mean cell haemoglobin concentration (%)		34.0	33.2	31.4	34.8
Urea nitrogen (mg/100 ml)				15	10
Phosphorus (mg/100ml)				9.05	5.80
Alkaline phosphatase (King Armstrong units)				12.6	15.0
Serum glutamic phosphoric transaminase (Reitman Frankel units)					
Total protein (g/100 ml)				5.90	5.40
Albumin (g/100 ml)				2.75	2.75
Globulin (g/100 ml)				3.15	2.65
Albumin/Globulin ratio				0.87	1.04

APPENDIX TABLE : A 2 (continued)

118	122	125	129	132	137	139	143	146
15/7	19/7	22/7	26/7	29/7	3/8	5/8	9/8	12/8
56	47	51	41	38	43	43	37.5	44
15.0	15.1	16.5	13.6	12.8	13.2	13.5	12.8	14.1
6.55	6.51	6.39	6.04	5.72	5.76	5.82	5.72	6.65
-	-	176	191	-	320	-	-	169
12.9	13.2	18.6	13.0	13.7	15.2	13.1	12.5	14.1
39	36	42	46	45	41	34	40	36
59	55	53	49	50	52	56	52	47
0	0	0	0	0	0	0	0	4
2	9	5	5	5	7	10	8	13
71	68	67	69	69	69	69	68	68
33.4	32.2	32.7	33.2	38.8	30.7	31.4	34.2	32.1
					6.60		5.60	
					7.90		10.30	
					6.10		6.50	
					2.90		3.20	
					3.20		3.30	
					0.91		0.97	

PARAMETER	Days 1977	151 17/8	156 22/8	157 23/8	164 30/8
Packed cell volume (%)		41	44	39	41
Haemoglobin (g/100 ml)		13.7	14.3	12.2	13.2
Erythrocytes X $10^6/mm^3$		6.30	6.42	5.89	6.25
Nucleated erythrocytes (%)					
Platelets X $10^3/mm^3$		-	-	145	-
Leucocytes X $10^3/mm^3$		12.3	15.4	11.1	13.3
Neutrophils (%)		48	38	37	40
Lymphocytes (%)		40	54	51	48
Monocytes (%)		3	3	6	5
Eosinophils (%)		9	5	7	7
Mean cell volume (μm^3)		68	68	67	68
Mean cell haemoglobin concentration (%)		33.4	32.5	31.3	32.0
Urea nitrogen (mg/100 ml)				15	15
Phosphorus (mg/100 ml)				3.80	6.30
Alkaline phosphatase (King Armstrong units)				11.10	11.80
Serum glutamic phosphoric transaminase (Reitman Frankel units)					
Total protein (g/100 ml)				6.10	5.75
Albumin (g/100 ml)				2.90	2.50
Globulin (g/100 ml)				3.20	3.25
Albumin/Globulin ratio				0.91	0.77

APPENDIX TABLE : A 2 (continued)

172	174	209	212	214	216	220
7/9	9/9	14/10	17/10	19/10	21/10	25/10
46	42	48	42	38	43	46
14.4	13.1	15.3	14.6	12.0	14.6	14.8
6.81	5.99	6.58	6.21	5.31	6.41	6.39
-	205	439	416	-	475	412
13.1	12.1	9.9	14.9	12.8	11.9	11.2
44	36	32	52	25	33	45
55	54	53	40	63	59	48
1	0	5	3	2	0	0
0	10	10	5	11	8	7
68	71	69	69	68	68	68
32.0		32.0	35.0	31.7	34.0	32.0
20		30	20		15	25
7.05		6.20	6.60		5.20	7.15
14.25		4.85	5.70		6.90	6.55
			26			
7.10		5.75	6.25		6.00	6.40
3.70		2.65	2.50		3.00	3.10
3.40		3.10	3.75		3.00	3.30
1.09					1.00	

PARAMETER 1977	-72 6/1	-38 9/2	-30 17/2	-5 14/3
Packed cell volume (%)	42.0	48.0	42.5	43.0
Haemoglobin (g/100 ml)	13.9	14.7	13.3	14.0
Erythrocytes X $10^6/mm^3$	4.69	6.36	6.06	5.41
Nucleated erythrocytes (%)				
Platelets X $10^3/mm^3$	135	578	326	687
Leucocytes X $10^3/mm^3$	8.1	17.8	10.8	13.8
Neutrophils (%)	65	29	60	57
Lymphocytes (%)	29	67	34	36
Monocytes (%)	0	1	0	0
Eosinophils (%)	6	3	6	7
Mean cell volume (μm^3)	66	70	71	75
Mean cell haemoglobin concentration (%)	33.1	33.2	31.4	32.6
Urea nitrogen (mg/100 ml)	35	25	35	40
Phosphorus (mg/100 ml)	6.80	9.15	9.05	8.55
Alkaline phosphatase (King Armstrong units)	18.20	7.85	15.70	17.70
Serum glutamic phosphoric transaminase (Reitman Frankel units)				
Total protein (g/100 ml)	5.00	5.75	5.25	5.40
Albumin (g/100 ml)	3.40	3.60	3.50	3.50
Globulin (g/100 ml)	1.60	2.15	1.75	1.90
Albumin/Globulin ratio	2.10	1.67	2.00	1.84

APPENDIX TABLE : A 3

SERUM BIOCHEMISTRY OF EXPERIMENTAL CASE 16750

0	4	6	9	10	11	12	13	16
19/3	23/3	25/3	28/3	29/3	30/3	31/3	1/4	4/4
35.5	41.0	39.0	42.0	49.1	47.0	41.0	45.0	42.0
11.0	12.5	12.4	13.5	14.5	15.2	14.8	14.4	14.7
4.24	5.36	5.32	5.42	6.07	7.16	6.12	5.93	5.80
294	N	220	-	-	-	258	-	-
11.6	13.8	13.4	11.0	12.3	14.7	14.8	14.0	12.2
47	54	46	46	53	44	47	49	29
49	41	49	51	47	56	51	49	69
0	0	1	3	0	0	0	0	1
4	5	4	0	0	0	2	2	1
79	70	73	71	78	67	70	73	75
31.0		31.8	32.2	30.0	32.4	34.6	32.0	35.0
25	25	25	20		25			
9.15	8.85	9.60	8.40		-			
11.30	21.70	20.30	16.80		-			
5.25	5.35	4.90	5.15		6.00			
3.25	3.50	3.15	3.35		3.00			
2.00	1.85	1.75	1.80		3.00			
1.62	1.89	1.80	1.86		1.00			

PARAMETER	Days 1977	18 6/4	19 7/4	22 10/4	24 12/4
Packed cell volume (%)		46.0	43.0	43.5	46.0
Haemoglobin (g/100 ml)		15.30	14.40	15.70	15.00
Erythrocytes X $10^6/mm^3$		6.21	5.83	6.12	6.33
Nucleated erythrocytes (%)					
Platelets X $10^3/mm^3$		418	-	-	-
Leucocytes X $10^3/mm^3$		13.1	12.1	14.1	12.8
Neutrophils (%)		50	42	37	34
Lymphocytes (%)		43	53	56	60
Monocytes (%)		0	0	1	0
Eosinophils (%)		7	5	6	6
Mean cell volume (μm^3)		68	69	68	69
Mean cell haemoglobin concentration (%)		33.2	33.6	36.1	32.6
Urea nitrogen (mg/100 ml)		25			
Phosphorus (mg/100 ml)		9.15			
Alkaline phosphatase (King Armstrong units)		16.7			
Serum glutamic phosphoric transaminase (Reitman Frankel units)					
Total protein (g/100 ml)		5.45			
Albumin (g/100 ml)		3.50			
Globulin (g/100 ml)		1.95			
Albumin/Globulin ratio		1.79			

APPENDIX TABLE : A 3 (continued)

26	30	32	37	39	41	45	47	51
14/4	18/4	20/4	25/4	27/4	29/4	3/5	5/5	9/5
44.5	46.0	47.0	49.0	45.0	44.0	46.0	49.0	46.0
15.40	15.30	15.50	16.20	14.70	14.50	15.20	15.90	15.30
6.12	6.10	6.39	6.59	6.12	6.12	6.25	6.53	6.30
				4				
168	-	318	-	376	-	221	214	218
14.7	12.7	13.3	11.3	14.8	13.3	12.4	10.8	12.2
36	32	37	40	40	36	41	44	35
57	61	55	54	49	60	51	56	61
0	0	0	2	2	0	0	0	0
7	7	8	4	9	4	8	0	4
69	69	70	69	69	69	69	69	68
34.6	33.3	33.0	33.0	32.6	33.0	33.1	32.4	32.2
	35		25				30	
	9.80		10.00				8.35	
	17.5		15.6				16.8	
	5.25		4.50				5.00	
	3.50		3.25				3.40	
	1.75		1.25				1.60	
	2.00		2.60				2.14	

PARAMETER	Days 1977	53 11/5	55 13/5	58 18/5	64 24/5
Packed cell volume (%)		49.0	49.0	48.0	51.5
Haemoglobin (g/100ml)		15.6	16.0	15.1	17.4
Erythrocytes X $10^6/mm^3$		6.74	6.14	6.26	6.88
Nucleated erythrocytes (%)					
Platelets X $10^3/mm^3$		-	-	180	-
Leucocytes X $10^3/mm^3$		11.6	10.9	9.0	10.3
Neutrophils (%)		37	41	44	23
Lymphocytes (%)		54	52	48	70
Monocytes (%)		1	1	2	0
Eosinophils (%)		8	6	6	7
Mean cell volume (μm^3)		70	68	68	68
Mean cell haemoglobin concentration (%)		31.9	32.8	36.0	33.8
Urea nitrogen (mg/100 ml)			20.0	27.0	
Phosphorus (mg/100 ml)			7.80	4.80	
Alkaline phosphatase (King Armstrong units)			8.4	11.1	
Serum glutamic phosphoric transaminase (Reitman Frankel units)					
Total protein (g/100 ml)			5.60	5.40	
Albumin (g/100 ml)			3.50	3.60	
Globulin (g/100 ml)			2.10	1.80	
Albumin/Globulin ratio			1.67	2.00	

APPENDIX TABLE : A 3 (continued)

67	71	74	78	79	81	83	85	88
27/5	31/5	3/6	7/6	8/6	10/6	12/6	14/6	17/6
49.0	53.0	55.0	50.0	43.0	49.5	50.5	50.5	50.0
17.4	17.2	17.7	16.9	16.2	15.9	16.2	16.5	16.3
6.57	6.51	7.33	7.48	7.00	7.04	6.68	6.92	7.03
129	-	122	-	182	-	280	-	180
10.5	13.7	11.9	12.2	13.2	17.1	14.8	18.8	21.1
45	33	52	38	45	58	39	53	54
50	59	45	56	40	38	47	40	40
0	0	0	0	3	0	0	0	0
5	8	3	6	12	4	14	7	6
68	67	64	69	67	70	70	69	68
31.5	36.4	32.2	33.8	35.4	32.2	32.0	32.9	32.6
30.0			25.0					32.0
5.95			7.60					8.10
16.1			12.8					12.2
4.90			4.80					4.75
3.10			2.90					3.25
1.80			1.90					1.50
1.72			1.53					2.16

APPENDIX TABLE : A 3 (continued)

PARAMETER	Days	92	94	99	106	116	120	123	127	130	135	137	141	144
	1977	21/6	23/6	28/6	5/7	15/7	19/7	22/7	26/7	29/7	3/8	5/8	9/8	12/8
Packed cell volume (%)		50.0	54.0	51.0	44.6	50.0	51.0	57.5	45.0	45.0	45.0	44.5	41.0	45.0
Haemoglobin (g/100 ml)		16.7	18.0	16.9	15.0	15.9	16.8	18.9	15.6	15.0	14.7	15.9	13.5	15.2
Erythrocytes X $10^6/mm^3$		6.92	6.52	7.18	6.71	6.47	6.58	6.23	6.41	6.20	6.17	6.23	5.81	6.69
Nucleated erythrocytes (%)														
Platelets X $10^3/mm^3$		-	256	220	389	-	-	174	194	-	250	-	-	203
Leucocytes X $10^3/mm^3$		21.7	20.7	15.8	15.0	16.7	16.6	15.7	15.7	15.5	16.7	19.2	17.5	17.1
Neutrophils (%)		58	64	45	43	53	41	54	53	45	56	37	41	42
Lymphocytes (%)		35	28	40	48	35	38	38	34	37	25	27	38	32
Monocytes (%)		0	0	0	0	0	0	0	0	0	0	0	0	2
Eosinophils (%)		7	8	15	9	12	21	8	13	18	9	14	21	24
Mean cell volume (μm^3)		68	68	68	67	71	72	70	72	72	73	72	71	73
Mean cell haemoglobin concentration (%)		33.4	33.3	33.2	33.6	35.5	33.0	33.0	34.7	33.2	32.4	35.8	33.0	33.8
Urea nitrogen (mg/100 ml)				30	25									
Phosphorus (mg/100 ml)				8.45	7.05						7.27		6.25	
Alkaline phosphatase (King Armstrong units)				18.2	16.7						13.3		10.6	
Serum glutamic phosphoric transaminase (Reitman Frankel units)														
Total protein (g/100 ml)				5.20	5.00						5.60		6.40	
Albumin (g/100 ml)				3.10	3.10						3.10		3.10	
Globulin (g/100 ml)				2.10	1.90						2.50		3.30	
Albumin/Globulin ratio				1.48	1.63						1.24		0.94	

PARAMETER	Days 1977	149 17/8	154 22/8	155 23/8
Packed cell volume (%)		40.5	47.0	49.0
Haemoglobin (g/100 ml)		13.9	15.4	14.6
Erythrocytes X $10^6/mm^3$		5.81	6.27	6.27
Nucleated erythrocytes (%)				
Platelets X $10^3/mm^3$		-	-	156
Leucocytes X $10^3/mm^3$		15.1	15.8	17.7
Neutrophils (%)		55	59	49
Lymphocytes (%)		30	32	29
Monocytes (%)		1	2	0
Eosinophils (%)		14	7	22
Mean cell volume (μm^3)		72	73	73
Mean cell haemoglobin concentration (%)		34.3	32.8	30
Urea nitrogen (mg/100 ml)				25
Phosphorus (mg/100 ml)				5.45
Alkaline phosphatase (King Armstrong units)				10.01
Serum glutamic phosphoric transaminase (Reitman Frankel units)				
Total protein (g/100 ml)				6.10
Albumin (g/100 ml)				3.60
Globulin (g/100 ml)				2.50
Albumin/Globulin ratio				1.44

APPENDIX TABLE : A 3 (continued)

162	170	172	177
30/8	7/9	9/9	14/10
47.0	43.0	50.0	54.0
14.9	14.3	16.1	18.5
6.45	6.09	6.67	7.16
-	-	208	314
18.8	14.6	15.2	11.6
50	50	51	42
28	41	41	37
1	0	0	2
21	9	8	16
72	70	75	74
32	33		34
25		30	
6.90		7.50	
16.40		16.40	
5.60		36.00	
3.40		3.35	
2.20		2.65	
1.55		1.26	

PARAMETER	Days 1977	-72 6/1	-38 9/2	-30 17/2	-5 14/3
Packed cell volume (%)		41.0	41.0	43.0	48.0
Haemoglobin (g/100 ml)		13.9	14.5	14.6	16.5
Erythrocytes X $10^6/mm^3$		5.64	5.90	6.35	6.39
Nucleated erythrocytes (%)					
Platelets X $10^3/mm^3$		157	420	320	276
Leucocytes X $10^3/mm^3$		16.3	16.7	18.3	16.4
Neutrophils (%)		48	36	57	60
Lymphocytes (%)		45	56	40	31
Monocytes (%)		3	3	0	4
Eosinophils (%)		4	5	3	5
Mean cell volume (μm^3)		65	68	76	70
Mean cell haemoglobin concentration (%)		34.9	35.4	34.0	34.6
Urea nitrogen (mg/100 ml)		30	20	22	35
Phosphorus (mg/100 ml)		7.40	7.80	9.45	7.50
Alkaline phosphatase (King Armstrong units)		19.3	16.0	16.2	14.3
Serum glutamic phosphoric transaminase (Reitman Frankel units)					
Total protein (g/100 ml)		5.00	5.60	5.92	6.35
Albumin (g/100 ml)		3.00	3.70	3.75	4.00
Globulin (g/100 ml)		2.00	1.90	2.17	2.35
Albumin/Globulin ratio		1.50	1.95	1.73	1.70

APPENDIX TABLE : A 4

SERUM BIOCHEMISTRY OF EXPERIMENTAL CASE 16751

0	4	6	9	10	11	12	13	16
19/3	23/3	25/3	28/3	29/3	30/3	31/3	1/4	4/4
45.5	44.0	46.0	47.0	50.6	46.0	49.0	54.0	47.0
14.1	14.8	14.8	15.7	16.8	15.8	16.9	15.8	16.0
5.36	6.14	6.13	6.22	6.89	6.59	6.57	6.76	6.40
510	-	246	-	-	-	434	-	-
15.6	18.4	17.1	17.5	15.4	16.9	18.7	16.0	19.1
73	54	55	56	60	53	45	49	53
26	31	31	42	38	39	45	43	41
0	8	4	0	0	2	1	0	0
1	7	10	2	2	6	9	8	6
76	69	71	76	72	70	69	73	74
31.0		32.2	33.4	33.4	34.4	34.5	33.4	35.0
20	20	25	20		30			
7.96	8.27	10.40	7.05		-			
15.1	17.0	17.7	14.1		-			
5.25	5.75	5.25	5.43		6.42			
3.35	3.65	3.35	3.35		4.25			
1.90	2.10	1.90	2.08		2.17			
1.76	1.74	1.76	1.61		1.96			

PARAMETER	Days 1977	18 6/4	19 7/4	22 10/4	24 12/4
Packed cell volume (%)		47.0	47.0	45.0	43.5
Haemoglobin (g/100 ml)		16.1	16.6	15.6	16.0
Erythrocytes X $10^6/mm^3$		6.55	6.54	6.13	6.58
Nucleated erythrocytes (%)					
Platelets X $10^3/mm^3$		544	-	-	-
Leucocytes X $10^3/mm^3$		17.8	17.7	17.6	18.6
Neutrophils (%)		44	44	57	44
Lymphocytes (%)		45	49	36	49
Monocytes (%)		0	0	0	0
Eosinophils (%)		11	7	7	7
Mean cell volume (μm^3)		69	69	68	68
Mean cell haemoglobin concentration (%)		34.3	35.4	34.9	36.8
Urea nitrogen (mg/100 ml)		20			
Phosphorus (mg/100 ml)		7.60			
Alkaline phosphatase (King Armstrong units)		13.60			
Serum glutamic phosphoric transaminase (Reitman Frankel units)					
Total protein (g/100 ml)		5.45			
Albumin (g/100 ml)		3.60			
Globulin (g/100 ml)		1.85			
Albumin/Globulin ratio		1.95			

APPENDIX TABLE : A 4 (continued)

26	30	32	37	39	41	45	47	51
14/4	18/4	20/4	25/4	27/4	29/4	3/5	5/5	9/5
48.0	48.0	50.0	50.0	50.0	49.0	54.0	51.0	53.0
17.3	16.3	17.6	16.8	16.6	16.9	18.4	17.3	18.2
6.87	6.57	7.44	6.84	6.85	7.12	7.53	7.04	7.23
				3				
244	-	354	-	201	-	203	194	189
17.9	13.7	17.5	13.2	19.8	18.0	15.4	14.8	15.3
49	45	32	52	47	40	40	40	26
48	49	60	32	38	57	48	53	65
0	0	0	2	5	0	6	0	0
3	6	8	14	10	3	6	7	9
69	69	70	70	68	69	70	68	68
36.0	34.0	35.2	33.4	33.1	33.5	34.1	34.0	34.3
	20		20				25	
	7.50		8.70				6.65	
	15.40		13.65				14.00	
	5.65		5.25				5.50	
	3.50		3.35				3.60	
	2.15		1.90				1.90	
	1.63		1.76				1.89	

PARAMETER	Days 1977	53 11/5	55 13/5	60 18/5	66 24/5
Packed cell volume (%)		54.0	53.0	52.0	52.0
Haemoglobin (g/100 ml)		17.8	17.7	17.2	18.6
Erythrocytes X $10^6/mm^3$		7.38	7.19	7.07	7.07
Nucleated erythrocytes (%)					
Platelets X $10^3/mm^3$		-	-	188	-
Leucocytes X $10^3/mm^3$		13.7	14.6	15.0	13.2
Neutrophils (%)		41	38	48	40
Lymphocytes (%)		53	50	44	55
Monocytes (%)		1	1	3	0
Eosinophils (%)		5	11	5	5
Mean cell volume (μm^3)		67	67	66	67
Mean cell haemoglobin concentration (%)		33.0	33.4	33.1	35.8
Urea nitrogen (mg/100 ml)			25	25	
Phosphorus (mg/100 ml)			7.2	5.6	
Alkaline phosphatase (King Armstrong units)			10.80	8.05	
Serum glutamic phosphoric transaminase (Reitman Frankel units)					
Total protein (g/100 ml)			5.75	5.25	
Albumin (g/100 ml)			3.60	4.10	
Globulin (g/100 ml)			2.15	1.15	
Albumin/Globulin ratio			1.67	1.85	

APPENDIX TABLE : A 4 (continued)

69	73	76	80	81	83	85	87	90
27/5	31/5	3/6	7/6	8/6	10/6	12/6	14/6	17/6
55.0	56.0	58.0	53.0	52.0	52.5	57.0	52.5	55.0
17.9	19.0	19.6	18.6	17.5	17.7	18.6	18.3	18.9
7.32	7.44	8.17	7.92	7.56	7.63	7.72	7.84	7.91
166	-	144	-	252	-	310	-	168
13.1	15.7	13.8	18.5	15.6	16.2	16.3	16.5	17.1
35	50	43	64	57	50	47	58	53
60	42	45	33	33	46	50	33	45
0	0	0	0	3	0	0	0	0
5	8	12	3	5	4	3	9	2
68	66	65	68	67	69	69	68	68
30.9	30.1	33.8	35.1	33.8	33.8	32.6	35.0	34.4
20			30					25
3.6			5.8					7.5
13.80			11.10					16.10
5.40			5.40					5.60
3.25			3.40					3.90
2.15			2.00					1.70
1.51			1.70					2.30

PARAMETER	Days 1977	94 21/6	96 23/6	101 28/6
Packed cell volume (%)		55.0	55.0	53.0
Haemoglobin (g/100 ml)		19.3	18.2	19.0
Erythrocytes X $10^6/mm^3$		7.93	7.76	7.84
Nucleated erythrocytes (%)				
Platelets X $10^3/mm^3$		-	240	310
Leucocytes X $10^3/mm^3$		17.2	16.5	16.3
Neutrophils (%)		53	50	49
Lymphocytes (%)		39	44	42
Monocytes (%)		0	0	0
Eosinophils (%)		8	6	9
Mean cell volume (μm^3)		68	70	67
Mean cell haemoglobin concentration (%)		35.0	33.0	35.8
Urea nitrogen (mg/100 ml)				20
Phosphorus (mg/100 ml)				7.4
Alkaline phosphatase (King Armstrong units)				17.7
Serum glutamic phosphoric transaminase (Reitman Frankel units)				
Total protein (g/100 ml)				4.90
Albumin (g/100 ml)				3.30
Globulin (g/100 ml)				1.60
Albumin/Globulin ratio				2.06

APPENDIX TABLE : A 4 (continued)

108	118	122	125	129	132	137	139	143	146
5/7	15/7	19/7	22/7	26/7	29/7	3/8	5/8	9/8	12/8
56.0	55.0	54.5	55.0	56.0	57.0	53.0	52.5	54.0	54.0
18.5	18.8	19.7	19.3	19.1	18.1	18.7	18.7	18.5	18.5
7.58	7.71	7.30	7.91	7.87	7.40	7.64	7.43	7.73	8.07
254	-	-	274	218	-	230	-	-	278
16.1	18.8	15.4	18.5	17.9	16.9	17.6	19.1	16.9	19.8
49	51	47	46	60	42	54	52	50	56
46	42	50	48	38	47	42	36	42	40
0	0	0	0	0	1	0	5	0	2
5	7	3	6	2	10	4	7	8	2
67	71	71	70	72	74	72	71	71	73
33.0	35.6	36.2	35.2	34.1	31.7	35.2	35.7	34.3	34.3
20									
6.3						6.6		5.2	
16.7						10.9		13.8	
5.25						5.95		6.20	
3.25						3.75		3.90	
2.00						2.20		2.30	
1.63						1.70		1.70	

PARAMETER	Days 1977	151 17/8	156 22/8	157 23/8	164 30/8
Packed cell volume (%)		51	51		53
Haemoglobin (g/100 ml)		18.6	17.8		17.7
Erythrocytes X $10^6/mm^3$		7.81	7.36		7.49
Nucleated erythrocytes (%)					
Platelets X $10^3/mm^3$		-	-		-
Leucocytes X $10^3/mm^3$		20.1	23.2		19.3
Neutrophils (%)		65	73		60
Lymphocytes (%)		29	21		24
Monocytes (%)		3	2		6
Eosinophils (%)		3	3		10
Mean cell volume (μm^3)		71	71		72
Mean cell haemoglobin concentration (%)		36.5	34.9		33.4
Urea nitrogen (mg/100 ml)				10	20
Phosphorus (mg/100 ml)				4.16	5.51
Alkaline phosphatase (King Armstrong units)				13.20	14.72
Serum glutamic phosphoric transaminase (Reitman Frankel units)					
Total protein (g/100 ml)				5.90	5.25
Albumin (g/100 ml)				3.40	3.75
Globulin (g/100 ml)				2.50	1.50
Albumin/Globulin ratio				1.36	2.50

APPENDIX TABLE : A 4 (continued)

172	174	209
7/9	9/9	14/10
55	54	55
17.9	17.4	18.8
7.68	7.40	7.47
-	168	349
16.0	17.6	16.3
57	56	47
38	35	35
2	1	4
4	7	14
73	74	73
33.0		34.0
30		
6.60		
15.20		
6.25		
3.85		
2.40		
1.60		

PARAMETER	Days 1977	-72 6/1	-38 9/2	-30 17/2	-5 14/3
Packed cell volume (%)		43.0	41.5	39.0	46.0
Haemoglobin (g/100 ml)		13.9	13.7	13.2	14.8
Erythrocytes X $10^6/mm^3$		5.08	6.00	6.00	5.84
Nucleated erythrocytes (%)					
Platelets X $10^3/mm^3$		188	380	300	225
Leucocytes X $10^3/mm^3$		7.8	7.1	16.1	14.9
Neutrophils (%)		63	48	64	76
Lymphocytes (%)		23	45	34	19
Monocytes (%)		8	3	0	1
Eosinophils (%)		6	3	2	4
Mean cell volume (μm^3)		62	69	74	76
Mean cell haemoglobin concentration (%)		32.3	33.0	33.9	32.4
Urea nitrogen (mg/100 ml)		25	20	30	30
Phosphorus (mg/100 ml)		7.00	6.75	9.65	8.95
Alkaline phosphatase (King Armstrong units)		10.30	11.50	12.05	10.80
Serum glutamic phosphoric transaminase (Reitman Frankel units)					
Total protein (g/100ml)		5.00	5.05	5.15	5.85
Albumin (g/100 ml)		3.00	3.10	3.35	3.75
Globulin (g/100 ml)		2.00	1.95	2.80	2.15
Albumin/Globulin ratio		1.50	1.59	1.20	1.74

APPENDIX TABLE : A 5

SERUM BIOCHEMISTRY OF EXPERIMENTAL CASE 16752

0	4	6	9	10	11	12	13	16
19/3	23/3	25/3	28/3	29/3	30/3	31/3	1/4	4/4
44.0	45.0	42.0	48.0	46.2	50.0	50.0	51.0	45.0
15.1	14.2	13.9	15.4	15.8	16.2	17.3	14.8	15.7
5.71	5.88	5.72	6.55	6.33	6.17	6.81	5.92	6.32
226	N	182	-	-	-	184	-	-
12.9	12.6	10.5	15.8	11.2	13.0	11.0	11.3	13.7
44	72	60	55	62	50	34	51	49
47	25	38	36	38	50	63	40	47
3	1	0	3	0	0	1	5	0
6	2	2	6	0	0	2	4	4
70	71	74	72	71	81	72	73	74
36.3		33.1	32.1	34.5	32.5	34.7	35.2	35.0
25	20	25	25		25			
7.96	8.65	8.00	8.70		-			
10.10	10.30	10.30	9.40					
5.45	5.40	5.43	5.75		5.92			
3.65	3.60	3.50	3.75		3.65			
1.80	1.80	1.93	2.00		2.27			
2.03	2.00	1.82	1.88		1.61			

PARAMETER	Days 1977	18 6/4	19 7/4	22 10/4	26 14/4
Packed cell volume (%)		44.0	43.0	42.0	46.0
Haemoglobin (g/100 ml)		15.4	14.6	13.8	15.8
Erythrocytes X $10^6/mm^3$		5.98	5.97	5.78	6.57
Nucleated erythrocytes (%)					
Platelets X $10^3/mm^3$		541	-		198
Leucocytes X $10^3/mm^3$		14.1	12.3	15.7	15.7
Neutrophils (%)		40	49	44	52
Lymphocytes (%)		56	47	48	48
Monocytes (%)		1	0	1	0
Eosinophils (%)		3	4	7	0
Mean cell volume (μm^3)		68	69	68	69
Mean cell haemoglobin concentration (%)		35.0	34.0	32.9	35.2
Urea nitrogen (mg/100 ml)		15			
Phosphorus (mg/100 ml)		7.80			
Alkaline phosphatase (King Armstrong units)		9.45			
Serum glutamic phosphoric transaminase (Reitman Frankel units)					
Total protein (g/100 ml)		5.45			
Albumin (g/100 ml)		3.50			
Globulin (g/100 ml)		1.95			
Albumin/Globulin ratio		1.80			

APPENDIX TABLE : A 5 (continued)

30	32	37	39	41	45	47	51	53
18/4	20/4	25/4	27/4	29/4	3/5	5/5	9/5	11/5
52.0	44.0	47.0	48.0	48.5	51.0	50.0	52.0	50.0
17.4	14.3	16.0	15.6	15.9	16.5	15.9	16.9	15.3
6.88	6.09	6.46	6.44	6.89	6.84	6.18	6.96	6.41
			11					
-	202	-	264	-	167	144	198	-
15.7	15.5	12.4	14.5	13.2	15.8	12.2	14.8	12.6
52	45	55	64	38	48	44	33	42
45	48	38	28	62	40	53	65	56
0	0	0	4	0	4	0	0	0
3	7	7	4	0	8	3	2	2
70	69	70	69	70	72	69	68	73
33.3	35.2	34.0	32.4	32.8	32.4	31.8	32.6	30.6
30		15				25		
11.90		8.80				6.95		
9.75		8.20				10.25		
5.60		4.10				5.40		
3.40		3.10				3.70		
2.20		1.00				1.70		
1.55		3.10				2.18		

PARAMETER	Days 1977	55 13/5	60 18/5	66 24/5	69 27/5
Packed cell volume (%)		52.0	44.0	56.0	47.0
Haemoglobin (g/100 ml)		16	14.4	18.8	16.0
Erythrocytes X $10^6/mm^3$		6.71	6.27	7.38	6.53
Nucleated erythrocytes (%)					
Platelets X $10^3/mm^3$		-	236	-	248
Leucocytes X $10^3/mm^3$		15.5	11.4	10.5	11.2
Neutrophils (%)		36	39	37	34
Lymphocytes (%)		59	55	57	60
Monocytes (%)		1	4	1	0
Eosinophils (%)		4	2	5	6
Mean cell volume (μm^3)		67	68	71	67
Mean cell haemoglobin concentration (%)		30.8	32.8	33.5	34.0
Urea nitrogen (mg/100 ml)		15	15		25
Phosphorus (mg/100 ml)		7.90	5.00		6.15
Alkaline phosphatase (King Armstrong units)		9.2	10.5		14.4
Serum glutamic phosphoric transaminase (Reitman Frankel units)					
Total protein (g/100 ml)		5.35	4.60		4.80
Albumin (g/100 ml)		2.25	3.40		3.10
Globulin (g/100 ml)		3.10	1.20		1.70
Albumin/Globulin ratio		0.73	2.83		1.82

APPENDIX TABLE : A 5 (continued)

73	76	80	81	83	85	87	90	94
31/5	3/6	7/6	8/6	10/6	12/6	14/6	17/6	21/6
50.0	53.0	49.0	47.0	48.5	52.5	52.0	51.0	50.0
16.8	16.8	16.6	16.0	16.2	15.8	18.4	16.8	17.4
6.65	7.16	7.14	7.04	7.00	6.61	7.85	7.22	6.85
-	172	-	176	-	289	-	146	-
14.8	11.7	12.4	11.7	13.8	14.8	16.9	13.4	15.8
56	42	53	37	38	55	56	57	43
37	54	44	57	58	41	39	33	53
0	0	0	2	0	0	0	0	0
7	4	3	4	4	4	5	10	4
67	65	69	66	69	68	67	66	74
33.6	31.7	33.9	34.0	33.4	30.3	35.4	33.0	34.8
		20					30	
		7.00					8.55	
		13.3					14.4	
		4.90					5.40	
		3.20					3.75	
		1.70					1.65	
		1.88					2.28	

PARAMETER	Days 1977	96 23/6	101 28/6	108 5/7	118 15/7
Packed cell volume (%)		51	50	51	50
Haemoglobin (g/100 ml)		18.0	17.7	15.9	17.1
Erythrocytes X $10^6/mm^3$		7.11	7.36	6.83	7.11
Nucleated erythrocytes (%)					
Platelets X $10^3/mm^3$		220	278	148	-
Leucocytes X $10^3/mm^3$		14.4	14.0	12.3	14.4
Neutrophils (%)		43	42	43	49
Lymphocytes (%)		51	53	55	46
Monocytes (%)		0	0	0	0
Eosinophils (%)		6	5	2	5
Mean cell volume (μm^3)		69	67	67	71
Mean cell haemoglobin concentration (%)		35.3	35.4	31.2	35.5
Urea nitrogen (mg/100 ml)			25	20	
Phosphorus (mg/100 ml)			8.70	6.30	
Alkaline phosphatase (King Armstrong units)			9.7	16.1	
Serum glutamic phosphoric transaminase (Reitman Frankel units)					
Total protein (g/100 ml)			5.10	4.90	
Albumin (g/100 ml)			3.40	3.20	
Globulin (g/100 ml)			1.70	1.70	
Albumin/Globulin ratio			2.00	1.88	

APPENDIX TABLE : A 5 (continued)

122 19/7	125 22/7	129 26/7	132 29/7	137 3/8	139 5/8	143 9/8	146 12/8	151 17/8
51	56	51	50	47	47	51	50	40
18.2	18.3	17.5	17.0	15.3	15.6	17.3	16.3	14.1
6.91	7.42	7.27	6.98	6.42	6.17	7.00	7.32	5.89
-	154	185	-	300	-	-	201	-
14.4	13.7	15.1	15.6	13.2	14.8	12.8	14.9	12.5
55	51	50	50	49	54	50	46	55
39	45	41	41	41	39	48	43	34
0	0	0	1	0	0	0	4	0
6	4	9	8	10	7	2	7	11
70	69	72	72	72	73	71	72	70
35.7	32.6	34.3	34.0	32.5	33.2	34.5	32.6	35.2
				7.05		6.45		
				10.8		11.2		
				5.25		5.75		
				3.60		3.60		
				1.65		2.15		
				2.18		1.67		

PARAMETER	Days 1977	156 22/8	157 23/8	164 30/8	172 7/9
Packed cell volume (%)		51.0	47.0	47.0	51.5
Haemoglobin (g/100 ml)		17.0	15.7	15.6	16.7
Erythrocytes X $10^6/mm^3$		7.12	6.78	6.77	7.22
Nucleated erythrocytes (%)					
Platelets X $10^3/mm^3$		-	171	-	-
Leucocytes X $10^3/mm^3$		15.0	12.2	11.0	12.1
Neutrophils (%)		64	48	48	46
Lymphocytes (%)		31	42	48	46
Monocytes (%)		2	5	3	5
Eosinophils (%)		3	2	1	3
Mean cell volume (μm^3)		72	72	72	73
Mean cell haemoglobin concentration (%)		34.0	33.4	33.0	32.0
Urea nitrogen (mg/100 ml)			20	15	20
Phosphorus (mg/100 ml)			4.75	6.23	7.50
Alkaline phosphatase (King Armstrong units)			12.6	13.5	14.9
Serum glutamic phosphoric transaminase (Reitman Frankel units)					
Total protein (g/100 ml)			5.40	5.25	5.70
Albumin (g/100 ml)			3.60	3.75	3.60
Globulin (g/100 ml)			1.80	1.50	2.10
Albumin/Globulin ratio			2.00	2.50	1.71

APPENDIX TABLE : A 5 (continued)

174	209
9/9	14/9
53.0	55.0
17.3	18.7
7.40	7.79
241	237
12.9	11.3
59	57
33	26
1	4
6	12
72	72
	34.0

PARAMETER	Days 1977	-72 6/1	-38 10/2	-30 17/2	-5 14/3
Packed cell volume (%)		45.0	41.0	41.0	46.0
Haemoglobin (g/100 ml)		14.5	14.2	13.2	15.6
Erythrocytes X $10^6/mm^3$		6.39	6.19	6.03	6.28
Nucleated erythrocytes (%)					
Platelets X $10^3/mm^3$		164	428	280	240
Leucocytes X $10^3/mm^3$		9.0	11.4	13.2	16.9
Neutrophils (%)		23	65	41	37
Lymphocytes (%)		74	25	58	58
Monocytes (%)		0	3	1	0
Eosinophils (%)		3	7	0	5
Mean cell volume (μm^3)		59	66	66	69
Mean cell haemoglobin concentration (%)		32.2	34.4	32.2	34.4
Urea nitrogen (mg/100 ml)		30	20	28	
Phosphorus (mg/100 ml)		5.55	7.40	9.85	7.70
Alkaline phosphatase (King Armstrong units)		10.30	10.80	10.25	9.60
Serum glutamic phosphoric transaminase (Reitman Frankel units)					
Total protein (g/100 ml)		5.85	5.60	5.65	5.50
Albumin (g/100 ml)		3.10	3.50	3.60	3.50
Globulin (g/100 ml)		2.75	2.10	2.05	2.00
Albumin/Globulin ratio		1.13	1.67	1.76	1.75

APPENDIX TABLE : A 6

SERUM BIOCHEMISTRY OF EXPERIMENTAL CASE 16753

0	4	6	9	10	11	12	13	16
19/3	23/3	25/3	28/3	29/3	30/3	31/3	1/4	4/4
47.0	47.0	46.0	47.0	51.4	48.0	47.0	47.0	50.0
15.5	15.8	15.1	15.4	15.8	15.5	16.8	15.4	18.3
5.34	6.35	6.06	6.25	6.31	6.12	6.61	6.40	7.10
454	N	532	-	-	-	376	-	-
15.8	15.5	15.6	16.6	17.6	15.4	16.5	17.6	12.4
54	53	53	46	51	55	47	46	39
38	40	42	50	43	45	49	47	57
0	1	0	0	0	0	1	0	0
8	6	5	4	6	0	3	7	4
69	67	69	70	79	79	69	70	69
30.5		32.8	32.8	31.0	32.2	35.8	33.8	31.6
25	25	25	30		25			
7.70	6.85	7.80	6.93		-			
14.20	10.15	10.00	10.60		-			
5.75	5.50	5.25	5.35		5.92			
3.75	3.60	3.35	3.60		3.95			
2.00	1.90	1.90	1.75		1.97			
1.87	1.78	1.76	2.06		2.00			

PARAMETER	Days 1977	18 6/4	19 7/4	22 10/4	24 12/4
Packed cell volume (%)		45.0	45.0	43.0	48.0
Haemoglobin (g/100 ml)		16.1	15.2	14.8	15.7
Erythrocytes X $10^6/mm^3$		6.33	6.15	5.78	6.47
Nucleated erythrocytes (%)					
Platelets X $10^3/mm^3$		580	-	<N	<N
Leucocytes X $10^3/mm^3$		17.2	15.7	19.5	17.9
Neutrophils (%)		46	49	44	48
Lymphocytes (%)		48	45	47	45
Monocytes (%)		0	0	0	2
Eosinophils (%)		6	6	9	00
Mean cell volume (μm^3)		68	69	70	70
Mean cell haemoglobin concentration (%)		35.8	33.8	34.4	32.7
Urea nitrogen (mg/100 ml)		20			
Phosphorus (mg/100 ml)		5.85			
Alkaline phosphatase (King Armstrong units)		8.60			
Serum glutamic phosphoric transaminase (Reitman Frankel units)					
Total protein (g/100 ml)		5.60			
Albumin (g/100 ml)		3.60			
Globulin (g/100 ml)		2.00			
Albumin/Globulin ratio		1.80			

APPENDIX TABLE : A 6 (continued)

26	30	32	37	39	41	45	47	51
14/4	18/4	20/4	25/4	27/4	29/4	3/5	5/5	9/5
48.0	47.0	47.50	48.5	49.0	49.0	50.0	50.0	45.0
16.6	16.4	15.6	17.2	16.2	16.8	16.2	17.2	15.9
6.72	6.77	6.53	6.83	6.68	6.96	7.23	6.14	6.23
				5				
344	-	368	-	590	<N	243	278	223
17.1	19.1	16.8	15.4	16.3	16.8	16.2	10.9	16.2
44	50	38	36	51	55	46	46	46
49	42	46	59	32	39	41	54	47
0	0	0	0	3	0	4	0	0
7	8	6	5	4	4	9	0	7
68	68	68	69	68	69	72	69	70
34.6	35.0	32.9	35.5	33.0	33.6	32.4	34.4	35.3
	25		25				40	
	8.85		7.60				6.05	
	10.50		7.65				9.15	
	5.40		4.60				4.90	
	3.50		3.00				3.50	
	1.90		1.60				1.40	
	1.84		1.88				2.50	

PARAMETER	Days 1977	53 11/5	55 13/5	60 18/5	66 24/5
Packed cell volume (%)		46	46	47	52
Haemoglobin (g/100 ml)		15.1	15.6	15.7	16.7
Erythrocytes X $10^6/mm^3$		6.18	6.27	6.15	6.73
Nucleated erythrocytes (%)					
Platelets X $10^3/mm^3$		-	-	340	-
Leucocytes X $10^3/mm^3$		15.7	15.4	12.7	10.3
Neutrophils (%)		59	40	42	34
Lymphocytes (%)		35	53	53	58
Monocytes (%)		0	1	1	0
Eosinophils (%)		6	6	4	8
Mean cell volume (μm^3)		69	67	66	65
Mean cell haemoglobin concentration (%)		32.8	34.0	33.4	32.2
Urea nitrogen (mg/100 ml)			20	25	
Phosphorus (mg/100 ml)			6.12	7.60	
Alkaline phosphatase (King Armstrong units)			8.10	10.30	
Serum glutamic phosphoric transaminase (Reitman Frankel units)					
Total protein (g/100 ml)			5.35	4.75	
Albumin (g/100 ml)			3.10	3.40	
Globulin (g/100 ml)			2.25	1.35	
Albumin/Globulin ratio			1.38	2.50	

APPENDIX TABLE ; A 6 (continued)

69	73	76	80	81	83	85	87	90
27/5	31/5	3/6	7/6	8/6	10/6	12/6	14/6	17/6
48	48	53	49	47	50	53	49.5	46
15.8	16.2	18.0	17.2	15.7	16.5	16.6	17.0	15.9
6.36	6.54	7.43	7.00	6.88	7.12	6.87	7.20	6.89
101	-	204	-	144	-	315	-	196
14.4	17.5	15.4	16.2	14.6	16.1	16.0	16.4	17.2
40	39	38	48	36	41	53	49	45
51	58	51	45	54	54	42	46	51
0	0	0	0	0	0	0	0	0
9	3	11	7	10	5	5	9	4
66	75	64	67	67	67	68	66	68
33.0	33.8	38.4	35.2	33.4	33.0	31.4	34.4	34.6
20			25					25
4.60			7.20					7.25
8.50			11.10					12.70
5.20			5.00					5.10
3.10			3.10					3.40
2.10			1.90					1.70
1.48			1.63					2.00

PARAMETER	Days 1977	94 21/6	96 23/6	101 28/6	108 5/7
Packed cell volume (%)		53.0	52.0	48.0	51.0
Haemoglobin (g/100 ml)		18.8	17.8	16.9	16.9
Erythrocytes X $10^6/mm^3$		7.47	7.05	7.20	7.10
Nucleated erythrocytes (%)					
Platelets X $1^3/mm^3$		-	320	301	267
Leucocytes X $10^3/mm^3$		16.5	18.0	18.2	14.3
Neutrophils (%)		50	51	57	35
Lymphocytes (%)		39	41	38	59
Monocytes (%)		0	0	0	2
Eosinophils (%)		11	8	5	4
Mean cell volume (μm^3)		68	69	65	67
Mean cell haemoglobin concentration (%)		34.8	34.2	35.2	33.2
Urea nitrogen (mg/100 ml)				20	25
Phosphorus (mg/100 ml)				7.25	7.65
Alkaline phosphatase (King Armstrong units)				13.70	13.60
Serum glutamic phosphoric transaminase (Reitman Frankel units)					
Total protein (g/100 ml)				4.75	5.40
Albumin (g/100 ml)				3.25	3.40
Globulin (g/100 ml)				1.5	2.00
Albumin/Globulin ratio				2.17	1.70

APPENDIX TABLE ; A 6 (continued)

118	122	125	129	132	137	139	143	146
15/7	19/7	22/7	26/7	29/7	3/8	5/8	9/8	12/8
49.0	46.0	47.0	39.0	48.0	36.5	35.0	35.0	37.0
16.3	17.2	15.2	13.8	13.7	12.0	12.8	12.4	12.0
6.79	6.52	6.18	5.84	5.88	5.07	5.03	5.27	5.46
-	-	218	179	-	280	-	-	245
14.8	15.0	14.1	13.4	16.3	19.7	18.6	19.0	14.9
38	46	54	47	42	53	70	50	60
57	52	40	41	52	40	27	35	30
0	0	0	0	2	1	0	2	2
5	2	6	12	4	6	3	13	8
71	70	70	70	72	71	71	74	70
34.9	37.0	32.3	35.4	33.6	32.9	36.6	35.4	32.5
					6.82		5.60	
					11.10		12.90	
					4.45		5.50	
					3.70		3.60	
					0.75		1.90	
					4.93		1.89	

PARAMETER	Days 1977	151 17/8	156 22/8	157 23/8	164 30/8
Packed cell volume (%)		31.5	35.0	37.0	38.0
Haemoglobin (g/100 ml)		10.8	11.3	11.7	12.0
Erythrocytes X $10^6/mm^3$		4.60	4.82	5.31	5.32
Nucleated erythrocytes (%)					
Platelets X $10^3/mm^3$		-	-	304	-
Leucocytes X $10^3/mm^3$		12.8	16.7	14.4	13.7
Neutrophils (%)		54	65	46	63
Lymphocytes (%)		37	29	42	28
Monocytes (%)		2	3	1	4
Eosinophils (%)		7	3	11	5
Mean cell volume (μm^3)		69	70	72	71
Mean cell haemoglobin concentration (%)		34.4	31.7	31.7	33.0
Urea nitrogen (mg/100 ml)				20	15
Phosphorus (mg/100 ml)				5.25	5.71
Alkaline phosphatase (King Armstrong units)				14.7	15.3
Serum glutamic phosphoric transaminase (Reitman Frankel units)					
Total protein (g/100 ml)				5.60	4.90
Albumin (g/100 ml)				3.25	3.60
Globulin (g/100 ml)				2.35	1.30
Albumin/Globulin ratio				1.38	2.77

APPENDIX TABLE : A 6 (continued)

172	174
7/9	9/9
45.0	45.0
14.6	14.3
6.41	6.34
-	254
14.8	15.3
69	38
26	49
1	2
5	11
72	71
32.0	
30	
8.65	
14.9	
6.10	
3.60	
2.50	
1.44	

PARAMETER	Days 1977	-72 11/1	-38 9/2	-30 17/2	-5 14/3
Packed cell volume (%)		36	40	42	45
Haemoglobin (g/100 ml)		11.7	13.5	13.7	15.3
Erythrocytes X $10^6/mm^3$		5.68	6.12	6.42	6.38
Nucleated erythrocytes (%)					
Platelets X $10^3/mm^3$		143	375	276	443
Leucocytes X $10^3 mm^3$		14.9	19.7	15.4	15.0
Neutrophils (%)		37	52	55	57
Lymphocytes (%)		42	45	41	31
Monocytes (%)		1	0	0	0
Eosinophils (%)		20	3	4	2
Mean cell volume (μm^3)		57	69	64	70
Mean cell haemoglobin concentration (%)		32.4	33.7	32.6	33.7
Urea nitrogen (mg/100 ml)		15	25	20	40
Phosphorus (mg/100 ml)		8.10	6.30	8.30	6.05
Alkaline phosphatase (King Armstrong units)		10.0	11.50	11.02	9.20
Serum glutamic phosphoric transaminase (Reitman Frankel units)					
Total protein (g/100 ml)		6.40	5.65	6.00	6.08
Albumin (g/100 ml)		2.60	3.10	3.35	3.25
Globulin (g/100 ml)		3.80	2.55	2.65	2.83
Albumin/Globulin ratio		0.685	1.22	1.26	1.15

APPENDIX TABLE : A 7

SERUM BIOCHEMISTRY OF EXPERIMENTAL CASE 16754

0	4	6	9	10	11	12	13	16
19/3	23/3	25/3	28/3	29/3	30/3	31/3	1/4	4/4
45	48	48	44	46	49	44	46	44
15.8	15.7	16.0	14.7	16.3	16.3	16.2	15.8	14.5
6.73	6.85	6.92	6.50	7.03	6.63	7.18	6.55	5.97
520	N	226	-	-	-	242	-	-
19.5	18.6	14.6	13.6	15.0	12.9	13.8	11.7	7.6
49	63	48	51	57	58	57	52	54
45	31	48	40	43	39	39	36	43
0	2	0	1	0	0	1	0	1
6	4	4	5	0	3	2	12	2
66	65	70	69	67	74	67	67	68
35.2		33.8	32.0	35.2	33.3	35.6	34.6	33.0
30	25	30	25		-			
6.55	7.10	7.50	7.14		-			
8.45	9.10	9.45	9.45		-			
6.25	6.60	6.15	6.42		7.35			
3.25	3.50	3.25	3.15		3.65			
3.00	3.10	2.90	3.27		3.70			
1.08	1.13	1.12	0.96		0.99			

PARAMETER	Days 1977	18 6/4	19 7/4	22 10/4	24 12/4
Packed cell volume (%)		42	40	36	37
Haemoglobin (g/100 ml)		14.8	13.8	12.6	12.7
Erythrocytes X $10^6/mm^3$		6.14	5.77	5.16	5.48
Nucleated erythrocytes (%)					
Platelets X $10^3/mm^3$		276	-	-	-
Leucocytes X $10^3/mm^3$		10.80	11.40	15.80	11.00
Neutrophils (%)		34	45	49	38
Lymphocytes (%)		60	49	50	61
Monocytes (%)		2	0	0	0
Eosinophils (%)		4	6	1	4
Mean cell volume (μm^3)		65	66	65	66
Mean cell haemoglobin concentration (%)		35.3	34.4	35.0	34.4
Urea nitrogen (mg/100 ml)		20			
Phosphorus (mg/100 ml)		5.85			
Alkaline phosphatase King Armstrong units)		10.55			
Serum glutamic phosphoric transaminase (Reitman Frankel units)					
Total protein (g/100 ml)		6.40			
Albumin (g/100 ml)		3.20			
Globulin (g/100 ml)		3.20			
Albumin/Globulin ratio		1			

APPENDIX TABLE ; A 7 (continued)

26	30	32	37	39	41	45	47	51
14/4	18/4	20/4	25/4	27/4	29/4	3/5	5/5	9/5
36	39	36	36.5	39	41	48	46	54
12.8	13.5	12.2	12.1	12.0	13.6	14.7	14.9	17.4
5.40	5.55	5.24	4.96	4.89	5.68	6.98	6.01	6.73
				17				
132	-	346	-	348	-	175	144	174
12.50	17.20	16.00	10.00	12.78	13.30	18.70	17.30	21.60
34	38	38	50	59	40	71	66	58
65	60	61	39	30	50	20	30	35
0	0	0	5	6	0	8	0	0
1	2	1	6	5	10	1	4	7
66	68	68	70	69	70	83	69	73
35.6	35.7	33.6	33.2	36.0	33.2	30.6	32.4	32.2
	25		20				25	
	6.08		11.70				5.60	
	9.75		9.00				8.60	
	6.10		4.40				5.90	
	2.60		2.60				2.75	
	3.50		1.80				3.15	
	0.74		1.44				0.88	

PARAMETER	Days 1977	53 11/5	55 13/5	60 18/5	66 24/5
Packed cell volume (%)		52	54	49	53.5
Haemoglobin (g/100 ml)		16.9	17.8	16.0	17.3
Erythrocytes X $10^6/mm^3$		6.88	7.14	6.79	7.23
Nucleated erythrocytes (%)					
Platelets X $10^3/mm^3$		-	-	240	-
Leucocytes X $10^3/mm^3$		14.9	15.1	13.7	16.7
Neutrophils (%)		54	59	50	47
Lymphocytes (%)		39	33	36	33
Monocytes (%)		2	1	2	1
Eosinophils (%)		5	7	12	19
Mean cell volume (μm^3)		68	70	66	66
Mean cell haemoglobin concentration (%)		32.5	32.8	32.6	32.4
Urea nitrogen (mg/100 ml)			20	30	
Phosphorus (mg/100 ml)			6.00	4.60	
Alkaline phosphatase (King Armstrong Units)			9.20	8.90	
Serum glutamic phosphoric transaminase (Reitman Frankel units)					
Total protein (g/100 ml)			6.92	6.40	
Albumin (g/100 ml)			3.10	3.00	
Globulin (g/100 ml)			3.82	3.40	
Albumin/Globulin ratio			0.81	0.88	

APPENDIX TABLE : A 7 (continued)

69	73	76	80	81	83	85	87	90
27/5	31/5	3/6	7/6	8/6	10/6	12/6	14/6	17/6
47	51	56	48	46	46	43	47	48
15.5	17.3	18.1	16.6	15.6	15.6	13.6	16.0	15.8
6.32	7.04	7.85	7.12	7.00	6.71	5.70	7.07	6.92
190	-	272	-	232	-	320	-	274
15.4	24.0	15.4	14.4	12.8	15.2	12.1	16.1	15.8
45	37	29	54	43	49	47	42	57
35	54	45	37	36	46	45	48	40
0	0	1	0	2	0	0	0	0
20	9	25	9	7	5	8	10	3
67	66	63	66	66	68	68	64	67
33.0	34.0	36.5	34.6	33.9	34.0	31.6	34.1	33.0
30			30					45
6.15			5.20					7.60
7.80			10.00					12.20
6.40			6.10					6.40
2.90			3.00					3.25
3.50			3.10					3.15
0.83			0.97					1.03

PARAMETER	Days 1977	94 21/6	96 23/6	101 28/6	108 5/7
Packed cell volume (%)		46.00	53.00	46.50	44.00
Haemoglobin (g/100 ml)		16.2	17.2	14.6	13.6
Erythrocytes X $10^6/mm^3$		6.95	6.41	6.35	5.90
Nucleated erythrocytes (%)					
Platelets X $10^3/mm^3$		-	230	193	159
Leucocytes X $10^3/mm^3$		15.1	14.6	10.9	9.2
Neutrophils (%)		40	50	56	42
Lymphocytes (%)		44	36	41	53
Monocytes (%)		0	0	0	0
Eosinophils (%)		16	14	3	5
Mean cell volume (μm^3)		66	68	66	66
Mean cell haemoglobin concentration (%)		35.2	33.4	31.4	30.9
Urea nitrogen (mg/100 ml)				35	25
Phosphorus (mg/100 ml)				18.51	19.05
Alkaline phosphatase (King Armstrong units)				14.3	12.8
Serum glutamic phosphoric transaminase (Reitman Frankel units)					
Total protein (g/100 ml				5.25	5.75
Albumin (g/100 ml)				2.60	2.75
Globulin (g/100 ml)				2.65	3.00
Albumin/Globulin ratio				0.98	0.92

APPENDIX TABLE : A 7 (continued)

118	122	125	129	132	137	139	143	146
15/7	19/7	22/7	26/7	29/7	3/8	5/8	9/8	12/8
47.00	49.50	59.50	49.00	49.00	51.50	47.00	49.00	46.00
15.2	16.8	19.0	16.3	16.4	17.6	16.4	16.9	16.0
6.51	5.81	7.30	6.80	6.66	7.24	6.53	7.30	7.36
-	-	132	152	-	316	-	-	253
12.6	12.8	13.0	15.1	16.5	13.8	14.6	12.8	13.1
39	47	50	39	38	36	50	49	34
44	43	44	46	47	50	38	34	56
0	0	0	0	2	0	0	3	0
7	10	6	15	13	13	12	14	10
70	74	70	69	71	70	67	69	69
34.6	34.0	32.0	33.2	33.5	34.2	34.9	34.5	34.7
					-			
					5.92		4.80	
					10.0		12.6	
					6.10		6.50	
					3.35		3.80	
					2.75		2.70	
					1.22		1.41	

PARAMETER	Days 1977	151 17/8	156 22/8	157 23/8	164 30/8
Packed cell volume (%)		47	50	50	52
Haemoglobin (g/100 ml)		16.3	16.7	16.6	17.1
Erythrocytes X $10^6/mm^3$		7.03	6.94	7.49	7.99
Nucleated erythrocytes (%)					
Platelets X $10^3/mm^3$		-	-	195	-
Leucocytes X $10^3/mm^3$		18.0	13.1	11.3	11.6
Neutrophils (%)		58	51	41	38
Lymphocytes (%)		30	37	47	46
Monocytes (%)		5	2	4	1
Eosinophils (%)		6	10	7	15
Mean cell volume (μm^3)		76	69	70	68
Mean cell haemoglobin concentration (%)		34.7	33.4	33.2	33.0
Urea nitrogen (mg/100 ml)				20	30
Phosphorus (mg/100 ml)				4.56	6.42
Alkaline phosphatase (King Armstrong units)				11.5	13.8
Serum glutamic phosphoric transaminase (Reitman Frankel units)					
Total protein (g/100 ml)				6.10	5.75
Albumin (g/100 ml)				3.40	3.40
Globulin (g/100 ml)				2.70	2.35
Albumin/Globulin ratio				1.26	1.45

APPENDIX TABLE ; A 7 (continued)

172	174	209	212	214
7/9	9/9	14/10	17/10	19/10
46	57	55	56	55
14.8	18.2	18.5	19.7	18.5
6.58	8.10	77.85	8.07	7.79
-	173	314	342	-
8.8	12.2	16.8	17.8	17.1
48	51	51	42	59
40	41	31	36	32
5	2	2	5	1
7	7	16	17	7
70	72	70	73	72
34.0		34.0	35.0	33.7
25				
6.80				
12.5				
6.20				
3.50				
2.70				
1.30				

PARAMETER	Days 1977	-72 6/1	-38 10/2	-30 17/2	-5 14/3
Packed cell volume (%)		36	38	36	43
Haemoglobin (g/100 ml)		11.8	13.0	11.3	14.2
Erythrocytes X $10^6/10^3$		3.98	4.84	4.83	5.04
Nucleated erythrocytes (%)					
Platelets X $10^3/mm^3$		171	466	212	339
Leucocytes X $10^3/mm^3$		9.7	14.0	16.1	13.1
Neutrophils (%)		31	44	69	52
Lymphocytes (%)		65	50	19	34
Monocytes (%)		2	0	4	4
Eosinophils (%)		2	6	8	10
Mean cell volume (μm^3)		75	64	72	77
Mean cell haemoglobin concentration (%)		32.8	34.2	31.4	32.8
Urea nitrogen (mg/100 ml)		25	15	20	35
Phosphorus (mg/100 ml)		5.75	7.60	10.05	9.40
Alkaline phosphatase (King Armstrong units)		13.50	12.70	12.00	9.45
Serum glutamic phosphoric transaminase (Reitman Frankel units)					
Total protein (g/100 ml)		5.20	6.00	6.57	5.00
Albumin (g/100 ml)		2.35	3.15	3.75	3.75
Globulin (g/100 ml)		2.85	2.85	2.82	1.25
Albumin/Globulin ratio		0.83	0.91	1.33	3.00

APPENDIX TABLE : A 8

SERUM BIOCHEMISTRY OF EXPERIMENTAL CASE 16755

0	4	6	9	10	11	12	13	16
19/3	23/3	25/3	28/3	29/3	30/3	31/3	1/4	4/4
45	42	42	42	47	44	44	41	41
15.1	13.6	14.3	14.1	14.9	14.5	14.6	13.8	14.0
6.08	4.97	5.30	5.30	7.12	4.93	4.99	5.15	5.71
460	N	214	-	-	-	290	-	-
20.6	14.7	14.0	10.6	10.7	9.9	10.3	11.3	8.5
47	62	55	46	41	44	44	52	52
42	27	35	46	52	47	49	36	32
0	1	0	0	1	1	0	1	0
16	10	10	8	6	8	7	11	6
69	74	80	77	78	89	78	77	81
33.6		34.3	34.8	32.0	33.0	35.2	35.0	34.2
25	25	20	20		20			
6.85	8.85	8.40	8.97		-			
9.85	10.55	10.30	10.90		-			
5.65	6.05	6.65	6.58		6.65			
3.60	3.50	3.08	3.50		3.25			
2.05	2.55	3.57	3.08		3.40			
1.76	1.37	0.86						

PARAMETER	Days 1977	18 6/4	19 7/4	22 10/4	24 12/4
Packed cell volume (%)		41	44	36	35.5
Haemoglobin (g/100 ml)		14.8	13.6	12.8	11.9
Erythrocytes X $10^6/mm^3$		5.37	5.19	4.51	4.91
Nucleated erythrocytes (%)					
Platelets X $10^3/mm^3$		394	-	-	-
Leucocytes X $10^3/mm^3$		9.7	8.6	10.5	7.6
Neutrophils (%)		39	48	45	51
Lymphocytes (%)		47	42	47	42
Monocytes (%)		0	0	1	0
Eosinophils (%)		14	10	7	7
Mean cell volume (μm^3)		74	74	72	73
Mean cell haemoglobin concentration (%)		36.2	31.0	35.6	33.6
Urea nitrogen (mg/100 ml)		20			
Phosphorus (mg/100 ml)		8.15			
Alkaline phosphatase (King Armstrong units)		9.17			
Serum glutamic phosphoric transaminase (Reitman Frankel units)					
Total protein (g/100 ml)		6.25			
Albumin (g/100 ml)		3.42			
Globulin (g/100 ml)		3.83			
Albumin/Globulin ratio		0.90			

APPENDIX TABLE ; A 8 (continued)

26	30	32	37	39	41	45	47	51
14/4	18/4	20/4	25/4	27/4	29/4	3/5	5/5	9/5
39	37	36	35.5	35	33	37	39	36
14.1	13.1	12.1	11.7	11.3	11.0	12.3	11.9	11.7
5.21	4.66	4.86	4.12	4.41	3.93	4.06	4.67	4.25
		5		8				
246	-	154	-	552	<N	183	112	244
9.9	11.6	7.5	9.8	10.7	8.8	13.1	8.2	10.3
38	37	43	48	48	41	58	50	32
53	54	52	40	39	56	29	42	61
0	2	0	6	5	0	4	0	0
9	7	5	6	8	3	9	8	7
74	74	71	79	74	75	77	73	75
36.2	35.4	33.6	33.0	32.3	33.4	33.3	30.6	32.5
	15		10				30	
	10.00		9.35				7.50	
	10.30		8.20				9.15	
	5.65		4.75				6.10	
	2.75		2.70				3.00	
	2.90		2.05				3.10	
	0.95		1.32				0.96	

PARAMETER	Days 1977	53 11/5	55 13/5	60 18/5	66 24/5
Packed cell volume (%)		38	40	42	46
Haemoglobin (g/100 ml)		12.5	13.5	13.3	15.0
Erythrocytes X $10^6/mm^3$		4.51	4.78	5.25	5.36
Nucleated erythrocytes (%)					
Platelets X $10^3/mm^3$		-	-	148	-
Leucocytes X $10^3/mm^3$		9.8	10.3	10.3	8.8
Neutrophils (%)		40	33	42	36
Lymphocytes (%)		52	57	49	47
Monocytes (%)		0	2	3	0
Eosinophils (%)		8	8	6	7
Mean cell volume (µm)		74	72	72	73
Mean cell haemoglobin concentration (%)		33.0	33.8	31.65	32.6
Urea nitrogen (mg/100 ml)			10	15	
Phosphorus (mg/100 ml)			7.8	5.0	
Alkaline phosphatase (King Armstrong units)			9.45	10.80	
Serum glutamic phosphoric transaminase (Reitman Frankel units)					
Total protein (g/100 ml)			6.10	5.60	
Albumin (g/100 ml)			2.92	3.10	
Globulin (g/100 ml)			3.18	2.50	
Albumin/Globulin ratio			0.92	1.24	

APPENDIX TABLE ; A 8 (continued)

69	73	76	80	81	83	85	87	90
27/5	31/5	3/6	7/6	8/6	10/6	12/6	14/6	17/6
48	46	49	45.5	45.5	44	45	46	48
13.9	15.1	16.0	15.4	15.1	15.0	14.7	15.5	15.7
5.23	5.66	6.03	6.22	6.02	6.08	5.54	6.12	6.50
104	-	192	-	184	-	290	-	172
7.7	12.4	9.3	10.8	9.4	11.7	8.9	12.7	12.3
40	54	35	45	50	40	33	46	47
53	37	57	42	43	55	52	44	45
0	0	0	0	1	0	0	0	0
7	9	9	3	6	5	5	10	8
72	72	69	72	71	72	71	72	72
35.0	32.8	32.6	33.9	33.6	34.2	32.7	33.8	32.8
15			30					25
3.6			7.8					10.0
8.50			12.20					14.40
5.75			5.50					5.75
3.00			2.80					3.20
2.75			2.70					2.55
1.09			1.03					1.26

PARAMETER	Days 1977	94 21/6	96 23/6	101 28/6	108 5/7
Packed cell volume (%)		46	51	50	49
Haemoglobin (g/100 ml)		16.5	16.9	17.0	15.9
Erythrocytes X $10^6/mm^3$		6.39	6.45	6.57	6.28
Nucleated erythrocytes (%)					
Platelets X $10^3/mm^3$		-	184	252	257
Leucocytes X $10^3/mm^3$		10.0	12.3	8.7	9.3
Neutrophils (%)		32	50	36	34
Lymphocytes (%)		54	40	62	46
Monocytes (%)		0	0	0	0
Eosinophils (%)		14	10	2	20
Mean cell volume (μm^3)		71	82	71	70
Mean cell haemoglobin concentration (%)		35.9	33.2	34.0	32.5
Urea nitrogen (mg/100 ml)				20	15
Phosphorus (mg/100 ml)				8.05	6.75
Alkaline phosphatase (King Armstrong units)				14.6	21.6
Serum glutamic phosphoric transaminase (Reitman Frankel units)					
Total protein (g/100 ml)				5.10	5.10
Albumin (g/100 ml)				2.75	2.90
Globulin (g/100 ml)				2.35	2.20
Albumin/Globulin ratio				1.17	1.32

APPENDIX TABLE : A 8 (continued)

118	122	125	129	132	137	139	143	146
15/7	19/7	22/7	26/7	29/7	3/8	5/8	9/8	12/8
51	46	48.5	45	41.5	45	42.5	46	45
16.5	16.5	16.3	14.9	14.0	14.9	14.6	15.2	15.1
6.57	5.66	6.09	5.94	5.53	5.72	5.27	6.09	6.17
-	-	146	207	-	277	-	-	211
9.5	10.7	11.2	11.4	12.1	11.1	11.5	12.2	13.3
32	32	42	32	30	29	30	33	28
61	43	51	41	49	42	45	40	50
0	0	0	4	3	0	0	1	3
7	25	7	23	18	29	25	26	9
74	73	73	75	74	75	77	74	76
34.9	35.8	33.8	33.1	33.7	33.2	34.4	33.0	33.6
					-		-	
					7.27		6.45	
					11.4		13.8	
					5.95		6.75	
					3.00		3.45	
					2.95		3.30	
					1.02		1.05	

PARAMETER	Days 1977	151 17/8	156 22/8	157 23/8	164 30/8
Packed cell volume (%)		43	47		45
Haemoglobin (g/100 ml)		14.0	15.5		14.7
Erythrocytes X $10^6/mm^3$		5.40	6.15		6.21
Nucleated erythrocytes (%)					
Platelets X $10^3/mm^3$		-	-		-
Leucocytes X $10^3/mm^3$		10.8	13.0		11.7
Neutrophils (%)		32	38		38
Lymphocytes (%)		46	37		42
Monocytes (%)		3	3		1
Eosinophils (%)		19	22		18
Mean cell volume (μm^3)		72	75		75
Mean cell haemoglobin concentration (%)		32.6	34.5		33.0
Urea nitrogen (mg/100 ml)				20	15
Phosphorus (mg/100 ml)				4.66	6.38
Alkaline phosphatase (King Armstrong units)				14.60	15.00
Serum glutamic phosphoric transaminase (Reitman Frankel units)					
Total protein (g/100 ml)				6.25	6.40
Albumin (g/100 ml)				2.9	3.10
Globulin (g/100 ml)				3.35	3.30
Albumin/Globulin ratio				0.87	0.94

APPENDIX TABLE ; A 8 (continued)

172	174	209	212	214	217	221
7/9	9/9	14/10	17/10	19/10	21/10	25/10
43	47	54	51	49	50	51
14.5	14.8	16.9	17.7	16.3	17.7	17.5
5.90	5.94	6.28	6.38	6.21	6.14	6.58
-	196	214	252	-	470	266
13.8	14.9	12.7	15.0	13.4	13.3	13.7
38	39	22	43	47	33	46
40	37	50	31	35	46	42
1	4	5	3	2	0	2
20	20	23	22	13	21	10
75	78	78	76	77	76	75
34.0		31.0	35.0	33.3	35.0	34.0
25		25	28		12	25
7.75		6.55	8.50		6.72	7.85
14.00		7.25	9.70		7.80	10.70
			17			
6.75		6.25	7.40		6.25	7.10
3.10		3.20	3.10		3.40	3.35
3.65		3.05	4.30		2.85	3.75
0.85		1.05	0.72		1.19	0.89

PARAMETER	Days 1977	-72 6/1	-38 9/2	-30 17/2	-5 14/3
Packed cell volume (%)		38	36	36	42
Haemoglobin (g/100 ml)		12.6	10.6	10.9	13.4
Erythrocytes X $10^6/mm^3$		4.98	4.34	5.23	5.32
Nucleated erythrocytes (%)					
Platelets X $10^3/mm^3$		146	500	388	531
Leucocytes X $10^3/mm^3$		12.2	9.0	18.1	11.2
Neutrophils (%)		60	51	58	43
Lymphocytes (%)		34	38	31	48
Monocytes (%)		0	5	3	0
Eosinophils (%)		6	6	8	9
Mean cell volume (μm^3)		68	70	69	72
Mean cell haemoglobin concentration (%)		33.2	32.0	30.3	31.4
Urea nitrogen (mg/100 ml)		35	25	30	30
Phosphorus (mg/100 ml)		6.10	10.90	9.80	7.80
Alkaline phosphatase (King Armstrong units)		8.80	4.85	11.45	10.50
Serum glutamic phosphoric transaminase (Reitman Frankel units)					
Total protein (g/100 ml)		4.75	5.60	5.75	5.40
Albumin (g/100 ml)		2.70	3.10	3.15	3.15
Globulin (g/100 ml)		2.05	2.50	2.60	2.25
Albumin/Globulin ratio		1.32	1.24	1.21	1.40

APPENDIX TABLE : A 9

SERUM BIOCHEMISTRY OF EXPERIMENTAL CASE 16756

0	4	6	9	10	11	13	16	18
19/3	23/3	25/3	28/3	29/3	30/3	1/4	4/4	6/4
36	34	34	34	40	36	51	39	35
12.2	11.4	11.2	11.2	12.7	11.9	17.1	12.5	12.6
4.78	4.61	4.61	4.46	4.93	4.86	6.76	4.81	4.60
						3		2
344	N	388	-	-	-	-	-	214
11.4	16.8	13.9	13.7	15.6	11.9	14.0	12.5	15.0
49	60	43	50	49	57	42	53	32
45	32	48	37	50	38	47	42	61
0	0	0	3	0	2	0	2	0
6	8	9	10	1	3	11	3	7
74	71	72	73	79	74	71	83	72
34.0		33.0	33.0	32.0	33.0	33.7	32.1	36.0
25	20	30	30		35			20
9.43	8.85	9.60	8.35		-			7.50
9.45	11.10	10.60	11.20		-			9.45
6.00	5.25	5.15	5.43		5.50			5.25
3.45	3.15	3.00	2.95		3.25			3.10
2.55	2.10	2.15	2.48		2.25			2.15
1.35	1.50	1.40	1.19		1.44			1.44

PARAMETER	Days 1977	19 7/4	22 10/4	24 12/4	26 14/4
Packed cell volume (%)		36	39	38.5	36
Haemoglobin (g/100 ml)		11.0	14.2	12.9	12.6
Erythrocytes X $10^6/mm^3$		4.72	5.43	5.05	4.88
Nucleated erythrocytes (%)					
Platelets X $10^3/mm^3$		-	<N	<N	144
Leucocytes X $10^3/mm^3$		15.1	18.3	15.6	17.2
Neutrophils (%)		37	30	43	51
Lymphocytes (%)		52	49	51	42
Monocytes (%)		0	0	1	0
Eosinophils (%)		11	21	5	7
Mean cell volume (μm^3)		72	72	71	71
Mean cell haemoglobin concentration (%)		30.60	36.50	33.60	35.00
Urea nitrogen (mg/100 ml)					
Phosphorus (mg/100 ml)					
Alkaline phosphatase (King Armstrong units)					
Serum glutamic phosphoric transaminase (Reitman Frankel units)					
Total protein (g/100 ml)					
Albumin (g/100 ml)					
Globulin (g/100 ml)					
Albumin/Globulin ratio					

APPENDIX TABLE ; A 9 (Continued)

30	32	37	39	41	45	47	51	53
18/4	20/4	25/4	27/4	29/4	3/5	5/5	9/5	11/5
39	38	41.5	40	40	43	42	41	41
13.7	12.8	13.3	12.3	12.2	14.1	13.5	13.7	13.7
5.23	5.04	5.42	4.80	4.92	5.63	6.33	5.31	5.31
			2					
-	510	-	298	<N	358	152	231	-
15.6	16.3	17.1	17.2	19.9	16.9	13.7	16.2	12.5
55	49	50	46	45	37	36	30	33
42	47	38	40	47	49	53	61	52
0	0	3	2	0	3	0	0	0
3	4	9	12	8	11	11	9	5
71	70	72	71	72	72	65	71	71
35.10	33.70	32.00	31.00	30.60	32.80	32.20	33.40	33.40
40		15				30		
9.1		7.2				7.5		
9.20		7.65				10.00		
5.40		5.25				5.20		
3.00		2.50				3.10		
2.40		2.75				2.10		
1.25		0.91				1.47		

PARAMETER	Days 1977	55 13/5	60 18/5	66 24/5	69 27/5
Packed cell volume (%)		45	40.0	43.0	39.0
Haemoglobin (g/100ml)		15.1	12.3	14.0	12.8
Erythrocytes X $10^6/mm^3$		5.25	4.78	5.43	5.12
Nucleated erythrocytes (%)					
Platelets X $10^3/mm^3$		-	128	-	208
Leucocytes X $10^3/mm^3$		21.0	12.5	10.7	11.6
Neutrophils (%)		43	36	30	34
Lymphocytes (%)		52	47	58	55
Monocytes (%)		2	6	2	0
Eosinophils (%)		3	11	10	11
Mean cell volume (μm^3)		86	73	69	70
Mean cell haemoglobin concentration (%)		33.7	30.8	32.6	32.8
Urea nitrogen (mg/100 ml)		20	30		20
Phosphorus (mg/100 ml)		8.2	6.0		6.9
Alkaline phosphatase (King Armstrong units)		12.4	8.9		9.7
Serum glutamic phosphoric transaminase (Reitman Frankel units)					
Total protein (g/100 ml)		5.42	4.40		4.75
Albumin (g/100 ml)		2.85	2.60		2.70
Globulin (g/100 ml)		2.57	1.80		2.05
Albumin/Globulin ratio		1.11	1.45		1.32

APPENDIX TABLE ; A 9 (continued)

73 31/5	76 3/6	80 7/6	81 8/6	83 10/6	85 12/6	87 14/6	90 17/6	94 21/6
42.0	48.0	44.0	41.0	43.5	42.5	44.5	47.0	44.0
13.8	14.6	14.9	14.2	15.1	14.2	15.5	15.1	15.2
5.61	5.89	6.03	5.89	6.35	5.72	6.47	6.21	5.77
-	64.	-	136	-	272	-	148	-
16.8	16.0	18.3	12.6	16.1	16.3	15.4	17.1	16.9
43	42	50	35	35	51	47	36	49
52	48	44	49	56	43	52	53	47
0	0	0	0	0	0	0	0	0
5	10	6	6	9	6	1	11	4
68	66	69	70	70	70	71	71	69
32.9	30.4	33.9	34.4	34.7	33.4	34.8	32.2	34.5
		30					30	
		7.4					10.0	
		11.9					13.0	
		4.25					5.40	
		2.75					3.25	
		1.50					2.15	
		1.83					1.51	

PARAMETER	Days 1977	96 23/6	101 28/6	108 5/7	118 15/7
Packed cell volume (%)		47	46	44.4	51
Haemoglobin (g/100 ml)		15.7	14.9	15.1	14.7
Erythrocytes X $10^6/mm^3$		6.15	5.94	6.23	5.96
Nucleated erythrocytes (%)					
Platelets X $10^3/mm^3$		262	272	286	-
Leucocytes X $10^3/mm^3$		16.3	14.4	13.4	13.6
Neutrophils (%)		45	49	51	40
Lymphocytes (%)		51	44	46	53
Monocytes (%)		0	0	0	0
Eosinophils (%)		4	7	3	7
Mean cell volume (μm^3)		79	69	70	73
Mean cell haemoglobin concentration (%)		33.4	32.4	34.0	34.8
Urea nitrogen (mg/100 ml)			25	25	
Phosphorus (mg/100 ml)			10.20	7.92	
Alkaline phosphatase (King Armstrong units)			14.30	15.50	
Serum glutamic phosphoric transaminase (Reitman Frankel units)					
Total protein (g/100 ml)			5.10	4.90	
Albumin (g/100 ml)			3.25	2.90	
Globulin (g/100 ml)			1.85	2.00	
Albumin/globulin ratio			1.76	1.45	

APPENDIX TABLE ; A 9 (continued)

122	125	129	132	137	139	143	146	151
19/7	22/7	26/7	29/7	3/8	5/8	9/8	12/8	17/8
42	47.5	43	44	45	45	46	46	40
14.5	15.3	14.9	15.7	15.0	15.4	14.7	15.6	13.9
7.68	7.60	6.08	6.27	5.94	5.35	5.81	6.83	5.70
-	106	209	-	270	-	-	101	-
14.6	15.5	18.2	18.0	15.1	16.4	13.8	17.8	11.5
50	40	53	44	66	44	52	40	38
42	47	35	47	29	40	38	48	44
0	0	0	2	1	2	0	3	4
8	13	12	7	4	14	10	9	14
72	69	74	75	74	74	75	74	71
34.6	32.7	34.7	35.7	33.15	34.2	32.0	33.9	34.8
				7.50		7.30		
				9.55		12.35		
				5.75		6.20		
				3.25		3.20		
				2.50		3.00		
				1.30		1.07		

PARAMETER	Days 1977	156 22/8	157 23/8	164 30/8	172 7/9
Packed cell volume (%)		45		43	41
Haemoglobin (g/100 ml)		15.3		14.8	13.9
Erythrocytes X $10^6/mm^3$		6.21		6.46	5.52
Nucleated erythrocytes (%)					
Platelets X $10^3/mm^3$		-		-	-
Leucocytes X $10^3/mm^3$		14.6		16.6	17.0
Neutrophils (%)		45		53	61
Lymphocytes (%)		46		37	28
Monocytes (%)		0		4	0
Eosinophils (%)		9		5	12
Mean cell volume (μm^3)		73		73	72
Mean cell haemoglobin concentration (%)		34.0		32.5	32.0
Urea nitrogen (mg/100 ml)			20	30	30
Phosphorus (mg/100 ml)			4.82	6.19	7.50
Alkaline phosphatase (King Armstrong units)			12.35	13.5	13.1
Serum glutamic phosphoric transaminase (Reitman Frankel units)					
Total protein (g/100 ml)			5.90	5.40	5.85
Albumin (g/100 ml)			3.30	3.30	3.20
Globulin (g/100 ml)			2.6	2.10	2.65
Albumin/Globulin ratio			1.27	1.57	1.21

APPENDIX TABLE : A 9 (continued)

174	209
9/9	14/10
42	51
14.2	16.5
5.95	6.51
200	201
16.2	14.1
48	60
38	27
1	2
13	8
75	74
	32.0

PARAMETER	Days 1977	-72 6/1	-38 9/2	-30 17/2	-5 14/3
Packed cell volume (%)		43.0	45.0	42.5	46.0
Haemoglobin (g/100ml)		14.1	14.0	13.4	15.4
Erythrocytes X $10^6/mm^3$		6.38	6.25	5.94	6.21
Nucleated erythrocytes (%)					
Platelets X $10^3/mm^3$		262	474	334	180
Leucocytes X $10^3/mm^3$		13.1	14.0	19.90	5.90
Neutrophils (%)		56	48	78	55
Lymphocytes (%)		30	44	18	37
Monocytes (%)		1	1	1	0
Eosinophils (%)		13	7	3	8
Mean cell volume (μm^3)		67	70	68	75
Mean cell haemoglobin concentration (%)			32.4	31.6	31.8
Urea nitrogen (mg/100 ml)		20	20	20	25
Phosphorus (mg/100 ml)		6.85	8.50	9.10	8.14
Alkaline phosphatase (King Armstrong units)		11.70	5.40	10.90	8.95
Serum glutamic phosphoric transaminase (Reitman Frankel units)					
Total protein (g/100 ml)		5.20	5.60	5.30	5.75
Albumin (g/100 ml)		2.75	3.25	3.35	3.65
Globulin (g/100 ml)		2.45	2.35	1.95	2.10
Albumin/Globulin ratio		1.13	0.75	1.72	1.74

APPENDIX TABLE : A 10

SERUM BIOCHEMISTRY OF EXPERIMENTAL CASE 16758

0	4	6	9	10	11	12	13	16
19/3	23/3	25/3	28/3	29/3	30/3	31/3	1/4	4/4
44.0	-	45.0	45.0	52.5	50.0	45.0	47.0	48.0
15.0	-	14.8	15.0	16.5	16.8	16.5	15.5	16.0
6.02	-	5.63	6.22	7.10	6.63	6.61	6.20	6.69
402	-	270	-	-	-	188	-	-
14.30	-	16.80	13.10	14.90	10.70	13.00	14.90	12.60
60	-	57	64	59	70	47	61	64
34	-	30	30	37	30	50	35	31
0	-	0	2	2	0	1	1	0
6	-	3	6	2	0	2	3	5
71	-	72	73	72	75	71	71	92
34.1	-	32.9	33.4	31.5	33.6	34.5	32.8	33.3
20	30	20	15		25			
7.45	8.05	7.30	8.35		-			
8.45	11.70	8.56	9.45		-			
5.75	6.00	5.15	6.00		6.10			
4.00	4.10	3.50	3.95		4.35			
1.75	1.90	1.65	2.05		1.75			
2.29	2.16	2.12	1.93		2.48			

PARAMETER	Days 1977	18 6/4	19 7/4	22 10/4	24 12/4
Packed cell volume (%)		48	49	49	48.5
Haemoglobin (g/100 ml)		16.4	15.8	17.4	17.1
Erythrocytes X $10^6/mm^3$		6.58	6.39	6.91	7.03
Nucleated erythrocytes (%)					
Platelets X $10^3/mm^3$		454	-	-	N
Leucocytes X $10^3/mm^3$		12.2	11.9	16.7	12.8
Neutrophils (%)		60	50	32	60
Lymphocytes (%)		36	40	61	37
Monocytes (%)		0	0	0	0
Eosinophils (%)		4	10	7	3
Mean cell volume (μm^3)		68	69	68	69
Mean cell haemoglobin concentration (%)		34.2	32.3	35.6	35.4
Urea nitrogen (mg/100 ml)		20			
Phosphorus (mg/100 ml)		7.5			
Alkaline phosphatase (King Armstrong units)		10.0			
Serum glutamic phosphoric transaminase (Reitman Frankel units)					
Total protein (g/100 ml)		5.65			
Albumin (g/100 ml)		3.95			
Globulin (g/100 ml)		1.75			
Albumin/Globulin ratio		2.26			

APPENDIX TABLE : A 10 (continued)

26	30	32	37	39	41	45	47	51
14/4	18/4	20/4	25/4	27/4	29/4	3/5	5/5	9/5
48.5	48.0	49.0	50.5	52.0	51.5	54.0	53.0	54.0
16.6	18.2	16.5	17.2	16.4	17.0	18.6	17.0	17.6
6.79	7.02	6.78	6.99	6.66	6.96	7.76	6.72	7.05
				9				
302	-	332	-	280	N	187	166	273
14.0	18.6	12.6	10.7	11.6	11.4	14.1	10.5	11.3
57	38	63	63	68	61	61	60	55
29	60	29	27	23	31	33	32	41
0	0	0	0	2	0	0	0	0
14	2	8	10	7	8	6	8	4
68	68	68	70	68	69	75	68	68
34.2	38.0	33.7	34.1	31.4	33.0	34.5	32.0	32.6
	30		15				25	
	10.7		8.25				6.87	
	10.0		8.75				10.25	
	5.60		5.50				5.25	
	3.75		3.10				3.75	
	1.85		2.40				1.50	
	2.03		1.29				2.50	

PARAMETER	Days 1977	53 11/5	55 13/5	60 18/5	66 24/5
Packed cell volume (%)		52.0	53.0	52.0	55.0
Haemoglobin (g/100 ml)		16.8	18.0	17.0	18.5
Erythrocytes X $10^6/mm^3$		6.74	7.10	6.74	7.49
Nucleated erythrocytes (%)					
Platelets X $10^3/mm^3$		188	-	188	-
Leucocytes X $10^3/mm^3$		10.50	14.30	10.50	9.10
Neutrophils (%)		52	53	52	52
Lymphocytes (%)		40	36	40	42
Monocytes (%)		4	1	4	0
Eosinophils (%)		4	10	4	6
Mean cell volume (μm^3)		68	69	68	68
Mean cell haemoglobin concentration (%)		31.65	34.00	31.65	33.60
Urea nitrogen (mg/100 ml)			20	20	
Phosphorus (mg/100 ml)			6.80	6.35	
Alkaline phosphatase (King Armstrong units)			6.22	10.00	
Serum glutamic phosphoric transaminase (Reitman Frankel units)					
Total protein (g/100 ml)			5.65	5.25	
Albumin (g/100 ml)			3.60	3.75	
Globulin (g/100 ml)			2.05	1.50	
Albumin/Globulin ratio			1.76	2.50	

APPENDIX TABLE : A 10 (continued)

69	73	76	80	81	83	85	87	90
27/5	31/5	3/6	7/6	8/6	10/6	12/6	14/6	17/6
52.0	59.0	58.0	50.5	51.0	48.0	50.0	53.0	49.0
17.0	19.4	18.8	17.6	17.7	16.5	16.1	18.7	17.8
7.22	8.20	8.08	7.56	7.52	7.04	6.71	7.77	7.52
172	-	180	-	126	-	330	-	180
10.30	11.70	10.30	11.60	11.60	14.30	12.70	13.40	11.80
51	54	66	63	60	60	65	65	29
42	37	23	28	38	34	30	27	60
0	0	0	0	0	0	0	0	0
7	9	11	8	2	6	5	8	11
67	65	64	68	68	70	68	68	68
32.70	33.90	32.40	34.90	34.70	34.40	32.10	35.30	36.40
30			20					30
6.55			6.00					7.70
10.30			12.20					11.90
5.25			4.60					4.75
3.30			3.10					3.40
1.95			1.50					1.35
1.69			2.07					1.40

PARAMETER	Days 1977	94 21/6	96 23/6	101 28/6	108 5/7
Packed cell volume (%)		54.0	54.0	53.0	50.20
Haemoglobin (g/100 ml)		20.0	17.9	17.9	17.7
Erythrocytes X $10^6/mm^3$		8.13	7.33	7.36	7.47
Nucleated erythrocytes (%)					
Platelets X $10^3/mm^3$		-	250	290	189
Leucocytes X $10^3/mm^3$		13.7	13.8	11.8	10.9
Neutrophils (%)		49	60	60	61
Lymphocytes (%)		45	30	31	32
Monocytes (%)		0	0	0	0
Eosinophils (%)		6	10	9	7
Mean cell volume (μm^3)		68	70	68	68
Mean cell haemoglobin concentration (%)		37.1	33.1	33.8	35.2
Urea nitrogen (mg/100 ml)				25	20
Phosphorus (mg/100 ml)				8.50	7.20
Alkaline phosphatase (King Armstrong units)				10.30	15.50
Serum glutamic phosphoric transaminase (Reitman Frankel units)					
Total protein (g/100 ml)				5.00	4.90
Albumin (g/100 ml)				3.60	3.30
Globulin (g/100 ml)				1.40	1.60
Albumin/Globulin ratio				2.57	2.06

APPENDIX TABLE : A 10 (continued)

118	122	125	129	132	137	139	143	146
15/7	19/7	22/7	26/7	29/7	3/8	5/8	9/8	12/8
58.0	54.0	54.0	52.0	47.0	51.20	51.50	53.50	54.50
18.8	18.8	18.8	17.9	16.3	17.4	17.4	17.2	17.8
7.76	5.61	7.47	7.49	6.76	7.40	6.71	7.20	7.95
-	-	126	197	-	311	-	-	273
12.9	14.8	12.8	11.3	12.6	11.7	12.1	11.3	11.4
60	59	51	67	67	54	64	68	70
30	35	35	29	25	34	28	27	25
0	0	0	0	3	0	2	1	3
10	6	14	4	5	12	6	4	2
70	70	76	73	72	73	72	71	72
35.3	34.8	34.8	34.4	34.7	34.0	33.8	32.2	32.7
					-		-	
					6.82		5.20	
					9.15		11.80	
					5.25		6.10	
					3.35		3.90	
					1.90		2.20	
					1.76		1.77	

PARAMETER	Days 1977	151 17/8	156 22/8	157 23/8	164 30/8
Packed cell volume (%)		45.5	51.0		52
Haemoglobin (g/100 ml)		15.8	17.0		17.3
Erythrocytes X $10^6/mm^3$		6.69	7.07		7.49
Nucleated erythrocytes (%)					
Platelets X $10^3/mm^3$		-	-		-
Leucocytes X $10^3/mm^3$		10.9	12.8		13.2
Neutrophils (%)		61	49		71
Lymphocytes (%)		31	38		23
Monocytes (%)		4	5		2
Eosinophils (%)		4	8		4
Mean cell volume (μm^3)		71	72		71
Mean cell haemoglobin concentration (%)		34.8	34.0		33.4
Urea nitrogen (mg/100 ml)				25	25
Phosphorus (mg/100 ml)				4.55	6.25
Alkaline phosphatase (King Armstrong units)				11.70	14.10
Serum glutamic phosphoric transaminase (Reitman Frankel units)					
Total protein (g/100 ml)				7.40	5.10
Albumin (g/100 ml)				2.85	3.40
Globulin (g/100 ml)				4.55	1.70
Albumin/Globulin ratio				0.63	2.00

APPENDIX TABLE : A 10 (continued)

172	174	209	212	214	216	220
7/9	9/9	14/10	17/10	19/10	21/10	25/10
51	52	52	50	44	51	54
16.3	16.7	16.9	17.0	14.8	17.7	18.1
6.73	7.27	7.10	6.76	6.04	6.81	7.76
-	212	202	293	-	224	396
15.5	21.7	8.8	14.3	12.8	13.2	12.1
69	83	54	66	61	67	66
23	13	35	26	34	25	23
3	3	1	1	2	2	4
5	1	10	7	3	5	7
72	73	71	72	72	72	72
32.0		32.5	34.0	33.7	35.0	34.0
25		30	25		10	20
6 60		5.80	8.40		5.80	7.27
13.10		6.65	6.30		7.50	8.75
			29			
5.70		5.65	6.25		5.70	5.75
3.60		3.35	3.15		3.15	3.40
2.10		2.30	3.10		2.55	2.35
1.71		1.46	1.02		1.24	1.45

PARAMETER	Days 1977	-72 6/1	-38 10/1	-30 17/1	-5 14/3
Packed cell volume (%)		32	32	36	40
Haemoglobin (g/100 ml)		10.6	10.7	11.5	13.0
Erythrocytes X $10^6/mm^3$		4.10	4.21	5.03	5.82
Nucleated erythrocytes (%)					
Platelets X $10^3/mm^3$		132	512	370	304
Leucocytes X $10^3/mm^3$		9.6	10.3	11.8	9.7
Neutrophils (%)		65	59	68	54
Lymphocytes (%)		32	25	21	33
Monocytes (%)		0	4	2	0
Eosinophils (%)		3	12	9	3
Mean cell volume (μmm^3)		61	69	69	63
Mean cell haemoglobin concentration (%)		33.1	33.4	32.0	30.7
Urea nitrogen (mg/100 ml)		40	20	30	45
Phosphorus (mg/100 ml)		5.80	6.30	8.90	8.60
Alkaline phosphatase (King Armstrong units)		9.10	11.40	15.70	13.00
Serum glutamic phosphoric transaminase (Reitman Frankel units)					
Total protein (g/100 ml)		4.70	5.10	5.10	5.65
Albumin (g/100 ml)		2.50	3.10	3.42	3.65
Globulin (g/100 ml)		2.20	2.00	1.68	2.00
Albumin/Globulin ratio		1.14	1.55	2.03	1.82

APPENDIX TABLE : A 11

SERUM BIOCHEMISTRY OF EXPERIMENTAL CASE 16759

0	4	6	9	10	11	12	13	16
19/3	23/3	25/3	28/3	29/3	30/3	31/3	1/4	4/4
35	38	40	36	39.7	36	35	39	43
11.4	11.9	13.8	11.0	12.3	12.0	12.9	12.5	14.3
4.99	5.18	4.88	4.27	5.24	5.10	5.02	4.78	4.92
6	2							
533	N	364	-	-	-	406	-	-
12.8	13.9	18.0	11.0	12.7	10.0	13.1	16.1	11.3
68	54	53	63	71	52	50	55	47
30	32	39	32	27	45	40	40	47
0	2	0	0	0	0	2	0	0
2	11	8	5	2	3	7	5	6
77	70	71	70	74	71	71	70	78
32.6		34.8	30.6	31.0	33.3	37.0	33.0	33.3
30	40	40	30		25			
9.35	8.65	10.00	9.00		-			
13.40	17.00	16.85	14.10		-			
5.25	5.46	5.00	5.15		5.00			
3.45	3.60	3.25	3.25		3.50			
1.80	1.80	1.75	1.90		1.50			
1.92	2.00	1.86	1.71		2.33			

APPENDIX TABLE : A 11

PARAMETER	Days 1977	18 6/4	19 7/4	22 10/4	24 12/4	26 14/4	30 18/4	32 20/4
Packed cell volume (%)		34	35	34	39	37	45	43
Haemoglobin (g/100 ml)		12.4	12.0	11.6	12.9	13.3	14.5	14.5
Erythrocytes X $10^6/mm^3$		4.61	4.74	4.61	5.20	5.26	5.66	6.07
Nucleated erythrocytes (%)								
Platelets X $10^3/mm^3$		458	-	N	-	378	-	320
Leucocytes X $10^3/mm^3$		13.9	11.1	12.9	12.8	11.2	10.7	11.1
Neutrophils (%)		64	55	48	26	44	51	41
Lymphocytes (%)		34	36	44	69	37	42	47
Monocytes (%)		0	0	1	0	0	0	0
Eosinophils (%)		2	9	7	5	19	7	12
Mean cell volume (μm^3)		68	70	70	69	69	70	68
Mean cell haemoglobin concentration (%)		36.4	34.4	34.2	33.1	36.0	32.2	33.8
Urea nitrogen (mg/100 ml)		25					25	
Phosphorus (mg/100 ml)		8.95					9.80	
Alkaline phosphatase (King Armstrong units)		10.55					3.85	
Serum glutamic phosphoric transaminase (Reitman Frankel units)								
Total protein (g/100 ml)		4.92					5.10	
Albumin (g/100 ml)		3.42					3.10	
Globulin (g/100 ml)		1.50					2.00	
Albumin/Globulin ratio		2.28					1.55	

(continued)

37	39	41	45	47	51
25/4	27/4	29/4	3/5	5/5	9/5
41.5	41	36.5	40	38	39
13.3	13.3	12.6	13.8	11.7	12.6
5.54	5.50	5.23	5.24	4.88	4.99
	6				
-	334	-	376	180	254
10.5	13.4	13.1	14.1	9.5	11.8
49	51	49	66	53	43
43	28	39	24	39	46
0	9	0	5	1	0
8	12	12	5	7	11
77	68	69	71	69	70
32.0	32.4	34.6	34.5	30.8	32.4
20				45	
9.55				7.70	
12.00				12.00	
4.75				4.40	
3.00				3.20	
1.75				1.20	
1.71				2.66	

PARAMETER	Days 1977	53 11/5	55 13/5	60 18/5	66 24/5
Packed cell volume (%)		36	39	39	40
Haemoglobin (g/100 ml)		12	12.9	12.4	13.3
Erythrocytes X $10^6/mm^3$		4.86	4.41	4.74	5.03
Nucleated erythrocytes (%)					
Platelets X $10^3/mm^3$		-	-	204	-
Leucocytes X $10^3/mm^3$		9.6	11.3	9.9	8.0
Neutrophils (%)		52	52	50	48
Lymphocytes (%)		34	32	41	38
Monocytes (%)		0	1	5	0
Eosinophils (%)		14	15	3	14
Mean cell volume (μm^3)		69	70	70	68
Mean cell haemoglobin concentration (%)		33.3	33.1	31.8	33.2
Urea nitrogen (mg/100 ml)			27	20	
Phosphorus (mg/100 ml)			7.8	3.3	
Alkaline phosphatase (King Armstrong units)			7.05	12.5	
Serum glutamic phosphoric transaminase (Reitman Frankel units)					
Total protein (g/100 ml)			4.90	6.40	
Albumin (g/100 ml)			2.92	3.40	
Globulin (g/100 ml)			1.98	3.00	
Albumin/Globulin ratio			1.47	1.13	

APPENDIX TABLE ; A 11 (continued)

69	76	80	81	83	85	87	90	94
29/5	3/6	7/6	8/6	10/6	12/6	14/6	17/6	21/6
39	49	39	40	45	42	40	46	43
13.0	15.7	13.7	13.8	15.2	13.4	13.9	14.3	15.7
5.37	6.19	5.55	5.70	6.47	5.40	5.82	6.04	6.40
128	122	-	206	-	250	-	200	-
9.4	12.8	11.8	11.6	12.4	10.6	13.1	14.9	17.1
60	49	56	56	50	57	39	48	60
33	37	33	35	43	34	46	44	29
0	1	0	0	0	0	0	0	0
7	13	11	9	7	9	5	8	11
68	65	67	67	69	68	67	67	68
33.3	32.0	35.2	34.5	33.8	32.2	34.8	31.2	36.6
30		25					40	
7.5		6.6					6.13	
11.9		16.1					11.7	
5.00		4.90					4.90	
3.10		2.90					3.30	
1.90		2.00					1.60	
1.63		1.45					2.06	

PARAMETER	Days 1977	96 23/6	101 28/6	108 5/7	118 15/7
Packed cell volume (%)		42	40	44.9	42.9
Haemoglobin (g/100 ml)		14.9	13.3	14.9	15.1
Erythrocytes X $10^6/mm^3$		5.76	5.55	6.71	6.41
Nucleated erythrocytes (%)					
Platelets X $10^3/mm^3$		186	300	212	-
Leucocytes X $10^3/mm^3$		21.1	17.8	14.3	14.0
Neutrophils (%)		79	53	54	56
Lymphocytes (%)		15	36	41	40
Monocytes (%)		0	0	0	0
Eosinophils (%)		6	11	5	4
Mean cell volume (μm^3)		72	67	67	69
Mean cell haemoglobin concentration (%)		35.4	33.3	33.2	35.2
Urea nitrogen (mg/100 ml)			20	30	
Phosphorus (mg/100 ml)			12.8	7.82	
Alkaline phosphatase (King Armstrong units)			14.3	18.3	
Serum glutamic phosphoric transaminase (Reitman Frankel units)					
Total protein (g/100 ml)			4.75	5.25	
Albumin (g/100 ml)			3.10	3.70	
Globulin (g/100 ml)			1.65	1.55	
Albumin/Globulin ratio			1.88	2.39	

APPENDIX TABLE : A 11 (continued)

122	125	129	132	137	139	143	146	151
19/7	22/7	26/7	29/7	3/8	5/8	9/8	12/8	17/8
43	53	41	44	41	47	44.5	47	41
13.4	17.6	14.2	14.7	14.1	14.8	14.2	15.7	14.3
4.46	5.81	6.15	6.20	5.91	5.72	5.69	7.23	6.17
-	196	221	-	292	-	-	151	-
13.8	13.9	15.3	16.3	12.8	15.1	14.8	12.7	14.0
54	47	53	60	53	60	68	51	62
34	44	40	34	39	27	31	40	26
0	0	0	0	1	0	0	2	4
12	9	7	6	7	13	1	7	8
70	76	70	71	71	71	71	71	71
31.2	33.2	34.8	33.4	34.4	31.5	32.0	33.4	34.9
					-	-		
					8.20	7.50		
					11.45	10.90		
					5.25	5.80		
					3.45	4.00		
					1.80	1.80		
					1.92	2.22		

PARAMETER	Days 1977	156 22/8	157 23/8	164 30/8	172 7/9
Packed cell volume (%)		49		44	41.5
Haemoglobin (g/100 ml)		16.4		14.1	13.0
Erythrocytes X $10^6/mm^3$		6.87		6.22	5.64
Nucleated erythrocytes (%)					
Platelets X $10^3/mm^3$		-		-	-
Leucocytes X $10^3/mm^3$		12.6		13.3	9.3
Neutrophils (%)		49		60	64
Lymphocytes (%)		46		28	33
Monocytes (%)		1		5	0
Eosinophils (%)		4		7	4
Mean cell volume (μm^3)		71		71	72
Mean cell haemoglobin concentration (%)		33.5		33.0	31.0
Urea nitrogen (mg/100 ml)			15	25	40
Phosphorus (mg/100 ml)			5.29	6.66	7.50
Alkaline phosphatase King Armstrong units)			15.55	12.3	17.3
Serum glutamic phosphoric transaminase (Reitman Frankel units)					
Total protein (g/100 ml)			5.10	5.25	5.90
Albumin (g/100 ml)			2.75	3.40	3.70
Globulin (g/100 ml)			2.35	1.85	2.20
Albumin/Globulin ratio			1.17	1.84	1.68

APPENDIX TABLE : A 11 (continued)

174	209	212	214	216	220
9/9	14/10	17/10	19/10	21/10	25/10
46	52.5	48	39	45	42
14.8	16.5	16.0	13.8	17.5	16.3
6.38	6.72	6.35	5.58	6.66	6.89
240	345	310	-	310	361
12.3	9.9	19.8	12.2	15.1	16.2
56	50	69	53	60	58
36	34	20	43	38	25
0	1	7	1	0	1
8	15	4	3	2	16
71	71	73	71	70	69
	31.5	33.0	35.4	39.0	39.0
	40	25		25	40
	6.50	6.67		8.00	8.00
	6.65	11.70		11.60	11.55
	5.15	5.50		4.95	55.65
	3.35	3.15		3.40	3.40
	1.80	2.35		1.55	2.25
	1.86	1.34		2.19	1.51

PARAMETER	Days 1977	-20 16/2	-5 3/3	4 8/3	6 10/3
Packed cell volume (%)		41	32.5	39	39
Haemoglobin (g/100 ml)		13.7	13.4	13.0	13.2
Erythrocytes X $10^6/mm^3$		5.96	5.47	5.80	5.58
Nucleated erythrocytes (%)					
Platelets X $10^3/mm^3$		584	736	650	360
Leucocytes X $10^3/mm^3$		14.2	18.8	17.7	11.6
Neutrophils (%)		75	62	76	78
Lymphocytes (%)		18	23	15	14
Monocytes (%)		2	0	1	1
Eosinophils (%)		5	15	8	7
Mean cell volume (μm^3)		67	72	70	64
Mean cell haemoglobin concentration (%)		35.4	34.4	33.8	34.0
Urea nitrogen (mg/100 ml)		15	15	15	20
Phosphorus (mg/100 ml)		5.00	3.52		5.85
Alkaline phosphatase (King Armstrong units)		8.35	5.95		10.00
Serum glutamic phosphoric transaminase (Reitman Frankel units)					
Total protein (g/100 ml)		6.90	7.15		6.90
Albumin (g/100 ml)		2.75	2.75		3.00
Globulin (g/100 ml)		4.15	4.40		3.90
Albumin/Globulin ratio		0.66	0.625		0.77

APPENDIX TABLE : A 12

SERUM BIOCHEMISTRY OF EXPERIMENTAL CASE 16761

7	10	11	12	13	14	15	17	19
11/3	14/3	15/3	16/3	17/3	18/3	19/3	21/3	23/3
38	36	39	38	36	36	37	38	40
13.4	12.1	13.0	12.2	12.3	11.6	12.5	11.5	12.7
5.43	4.46	5.40	4.62	5.24	5.12	5.09	4.93	5.36
	4		10	5	3			
263	358	272	350	942	884	395	354	N
7.8	14.0	11.9	12.24	12.1	9.3	9.1	9.0	12.5
74	57	67	68	68	61	48	61	60
17	33	21	26	29	33	42	27	35
2	0	0	0	0	0	1	4	2
7	10	12	6	3	6	9	7	3
64	70	64	64	63	67	71	71	69
35.2	33.6	30.2	32.3	34.2		33.5	30.3	
20	35	30	25	20	20	25		15
6.20	7.50	6.63	5.95	7.16	6.10	5.85		5.70
12.15	11.10	10.50	8.90	8.65	7.85	7.95	6.40	8.65
		43	43					
7.40	7.58	7.35	6.85	7.00	7.15	7.50		7.25
3.08	3.25	2.85	3.10	3.00	3.00	3.10		3.10
4.32	4.33	4.50	3.75	4.00	4.15	4.40		4.15
0.715	0.75	0.63	0.83	0.75	0.725	0.705		0.745

PARAMETER	Days 1977	21 25/3	24 28/3	25 29/3	26 30/3
Packed cell volume (%)		30	39	41	46
Haemoglobin (g/100 ml)		10.0	12.8	13.0	12.6
Erythrocytes X $10^6/mm^3$		4.10	5.40	5.54	4.86
Nucleated erythrocytes (%)					
Platelets X $10^3/mm^3$		448	-	-	-
Leucocytes X $10^3/mm^3$		14.6	19.9	23.3	19.1
Neutrophils (%)		51	39	42	29
Lymphocytes (%)		44	56	57	69
Monocytes (%)		0	0	0	1
Eosinophils (%)		5	5	1	1
Mean cell volume (μm^3)		69	72	72	94
Mean cell haemoglobin concentration (%)		33.3	32.8	32.0	27.2
Urea nitrogen (mg/100 ml)		20	20		20
Phosphorus (mg/100 ml)		5.40	6.40		-
Alkaline phosphatase (King Armstrong units)		6.85	7.05		-
Serum glutamic phosphoric transaminase (Reitman Frankel units)					
Total protein (g/100 ml)		6.92	8.05		8.05
Albumin (g/100 ml)		2.75	3.00		3.35
Globulin (g/100 ml)		4.17	5.05		4.70
Albumin/Globulin ratio		0.66	0.59		0.71

APPENDIX TABLE : 12 (continued)

27	28	31	33	34	37	39	43	45
31/3	1/4	4/4	6/4	7/4	10/4	14/4	18/4	20/4
40	34	38	41	42	42	44	47	44
13.2	12.9	13.2	13.3	14.1	14.5	14.4	14.5	14.6
5.37	5.15	5.34	5.52	5.44	5.66	5.83	5.71	5.90
252	-	-	730	-	N	634	-	366
23.9	21.0	22.7	19.2	20.1	19.6	17.9	21.9	21.1
67	45	42	34	32	40	50	55	53
28	52	54	61	57	50	48	38	43
0	0	0	1	0	4	0	1	0
5	3	4	4	11	6	2	6	4
70	70	84	68	69	67	68	67	67
33.0	37.0	34.8	33.4	33.4	34.5	33.0	30.8	33.2
			25				20	
			5.85				5.37	
			6.70				2.00	
			7.75				7.25	
			3.20				3.00	
			4.55				4.25	
			0.71				0.71	

PARAMETER	Days 1977	50 25/4	52 27/4	54 29/4	58 3/5
Packed cell volume (%)		40.5	45	43	44
Haemoglobin (g/100 ml)		13.7	14.7	14.2	14.4
Erythrocytes X $10^6/mm^3$		5.47	5.90	5.72	6.00
Nucleated erythrocytes (%)			18		
Platelets X $10^3/mm^3$		-	728	N	517
Leucocytes X $10^3/mm^3$		23.7	16.4	18.8	21.3
Neutrophils (%)		56	60	39	37
Lymphocytes (%)		33	26	53	57
Monocytes (%)		4	6	0	0
Eosinophils (%)		7	8	8	6
Mean cell volume (μm^3)		68	68	70	70
Mean cell haemoglobin concentration (%)		33.9	32 .6	33.0	32.8
Urea nitrogen (mg/100 ml)		15			
Phosphorus (mg/100 ml)		8.05			
Alkaline phosphatase (King Armstrong units)		4.90			
Serum glutamic phosphoric transaminase (Reitman Frankel units)					
Total protein (g/100 ml)		4.90			
Albumin (g/100 ml)		3.25			
Globulin (g/100 ml)		1.65			
Albumin/globulin ratio		1.97			

APPENDIX TABLE : A 12 (continued)

60	64	66	68	71	78	80	84	88
5/5	9/5	11/5	13/5	18/5	25/5	27/5	31/5	3/6
46	46	46	46	48	44	41	41	46
14.6	14.7	14.6	13.9	14.2	14.5	14.4	13.7	14.8
5.76	5.88	6.07	4.46	5.76	5.76	5.32	5.38	6.30
554	410	-	-	384	-	310	-	408
15.5	18.6	16.6	15.8	16.9	16.7	19.3	14.0	19.3
50	43	51	51	53	53	58	59	43
42	50	44	40	36	38	38	35	51
0	0	0	2	2	0	0	0	0
8	7	5	7	9	7	4	6	6
67	68	67	74	67	67	68	71	65
31.8	32.0	31.8	30.3	36.8	33.0	35.1	33.4	32.2
30			20	25		25		
5.33			5.12	5.60		4.60		
7.15			12.40	8.65		8.50		
7.40			7.25	7.25		7.60		
3.20			2.75	3.25		3.00		
4.20			4.50	4.00		4.60		
0.76			0.61	0.81		0.65		

PARAMETER	Days 1977	92 7/6	93 8/6	95 10/6	97 12/6
Packed cell volume (%)		41	41.5	41	45
Haemoglobin (g/100 ml)		14.4	13.7	13.2	14.8
Erythrocytes X $10^6/mm^3$		5.85	5.78	6.65	4.74
Nucleated erythrocytes (%)					
Platelets X $10^3/mm^3$		-	382	-	224
Leucocytes X $10^3/mm^3$		22.7	19.3	13.1	17.2
Neutrophils (%)		59	56	55	58
Lymphocytes (%)		39	37	41	39
Monocytes (%)		0	0	0	0
Eosinophils (%)		2	7	4	3
Mean cell volume (μm^3)		69	70	70	69
Mean cell haemoglobin concentration (%)		35.2	33.5	32.2	33.0
Urea nitrogen (mg/100 ml)		20			
Phosphorus (mg/100 ml)		6.20			
Alkaline phosphatase (King Armstrong units)		9.70			
Serum glutamic phosphoric transaminase (Reitman Frankel units)					
Total protein (g/100 ml)		6.90			
Albumin (g/100 ml)		3.00			
Globulin (g/100 ml)		3.90			
Albumin/Globulin ratio		0.77			

APPENDIX TABLE : A 12 (continued)

99	102	106	108	113	120	130	134	137
14/6	17/6	21/6	23/6	28/6	5/7	15/7	19/7	22/7
46	39	40	42	37	29	36	36	45
15.5	13.0	14.2	13.5	11.6	10.0	11.9	11.9	14.9
6.12	5.55	5.63	5.49	4.71	4.05	4.87	4.41	4.54
-	384	-	470	268	169	-	-	440
12.7	18.3	17.8	17.1	14.6	16.6	14.7	19.6	17.1
46	56	52	72	51	50	45	60	45
44	44	40	27	43	47	50	31	50
0	0	0	0	0	0	0	0	0
10	0	8	1	6	3	5	9	5
72	68	69	70	66	67	72	74	79
33.8	33.3	35.5	32.2	31.4	34.5	35.5	33.0	33.0
	30			25	10			
	9.30			6.10	6.30			
	11.10			13.40	23.80			
	6.60			6.75	6.90			
	2.75			2.90	2.90			
	3.85			3.85	4.00			
	0.72			0.75	0.73			

PARAMETER	Days 1977	141 26/7	144 29/7	149 3/8	151 5/8
Packed cell volume (%)		32	33.5	37	39
Haemoglobin (g/100 ml)		11.4	11.4	12.8	12.4
Erythrocytes X $10^6/mm^3$		4.78	4.72	5.10	4.78
Nucleated erythrocytes (%)					
Platelets X $10^3/mm^3$		313	-	285	-
Leucocytes X $10^3/mm^3$		17.1	20.3	18.6	18.8
Neutrophils (%)		60	54	56	58
Lymphocytes (%)		37	44	38	38
Monocytes (%)		2	0	1	0
Eosinophils (%)		1	2	5	4
Mean cell volume (μm^3)		73	73	70	71
Mean cell haemoglobin concentration (%)		32.8	34.0	34.0	31.8
Urea nitrogen (mg/100 ml)					
Phosphorus (mg/100 ml)				5.45	
Alkaline phosphatase (King Armstrong units)				11.10	
Serum glutamic phosphoric transaminase (Reitman Frankel units)					
Total protein (g/100 ml)				7.40	
Albumin (g/100 ml)				2.75	
Globulin (g/100 ml)				4.65	
Albumin/Globulin ratio				0.59	

APPENDIX TABLE : A 12 (continued)

155	158	163	168	169	176	184	186
9/8	12/8	17/8	22/8	23/8	30/8	7/9	9/9
34	37	39	39	38	41	42	40
11.9	12.1	12.6	13.1	12.8	13.0	13.1	13.5
4.82	5.42	5.29	5.44	5.32	5.61	5.41	5.63
-	517	-	-	327	-	-	468
18.1	19.3	17.0	19.4	17.3	18.2	14.8	16.4
57	55	54	70	56	56	59	52
35	34	39	23	29	38	37	39
0	4	1	3	3	3	1	1
8	7	6	4	12	3	3	8
72	72	70	72	72	72	73	73
35.0	32.7	32.3	33.6	33.7	32.0	31.0	
				25	15	20	
4.80				4.55	5.70	5.00	
14.40				11.70	13.20	12.05	
7.70				7.40	7.10	7.20	
3.00				2.85	3.40	3.00	
4.70				4.55	3.70	4.20	
0.64				0.63	0.92	0.71	

APPENDIX TABLE : A 13

HAEMATOLOGICAL FINDINGS IN MASAI OWNED DOMESTIC DOGS IN NAROK AND KAJIADO DISTRICTS

	NAROK DOGS								KAJIADO DOGS			
PARAMETER	Dog 1	Dog 2	Dog 3	Dog 4	Dog 5	Dog 6	Dog 7	Dog 8	Dog 1	Dog 2	Dog 3	Dog 4
Packed cell volume (%)	34	33	35	35	38	30	31	42	33	40	16	36
Haemoglobin (g/100 ml)	10.40	10.30	11.20	12.20	12.40	10.40	10.90	13.70	10.90	13.10	5.20	13.10
Erythrocytes X $10^6/mm^3$	4.70	4.67	5.16	4.64	5.46	4.57	4.57	6.04	4.89	5.64	2.48	5.95
Leucocytes X $10^3/mm^3$	13.00	13.90	21.90	61.80	11.10	15.20	16.20	20.00	10.80	18.50	10.80	14.20
Neutrophils X $10^3/mm^3$	6.80	9.60	10.50	38.90	6.80	6.10	8.40	11.20	4.40	8.00	4.80	7.20
Lymphocytes X $10^3/mm^3$	6.10	2.60	9.40	11.70	3.60	7.40	6.50	6.00	5.20	7.80	5.40	5.00
Monocytes X $10^3/mm^3$	0.30	0	0.20	0	0	0	0	0	0	0	0	0
Eosinophils X $10^3/mm^3$	0.70	1.70	1.80	11.10	0.80	1.70	1.30	2.80	1.20	2.80	0.60	2.00
Basophils X $10^3/mm^3$	0	0	0	0	0	0	0	0	0	0	0	0
Mean cell volume (μm^3)	72	71	71	78	69	71	74	73	67	72	67	67
Mean cell haemoglobin concentration (%)	31.0	31.2	32.0	34.8	32.6	34.7	35.2	32.6	33.1	32.8	32.6	36.4
Total protein (g/100 ml)	5.4	5.8	7.0	8.0	6.4	7.6	7.8	7.4	8.0	8.0	9.2	9.4

APPENDIX TABLE : A 14

HAEMATOLOGICAL FINDINGS IN FREE-LIVING JACKALS

PARAMETER	JACKAL NUMBER														
	1	2	4	5	6	7	8	9	10	11	12	13	29	30	31
Packed cell volume (%)	45	44	30	49	35	28	25	46	42	47	52	54	37	40	43
Haemoglobin (g/100 ml)	14.5	13.9	10.1	16.2	13.3	8.8	10.6	16.1	14.3	16.2	17.3	18.8	12.7	12.8	15.0
Erythrocytes X $10^6/mm^3$	5.48	5.99	3.93	6.46	5.76	3.59	3.56	6.44	5.84	6.44	6.71	7.44	5.24	5.29	6.25
Leucocytes X $10^3/mm^3$	12.90	2.90	14.60	6.50	4.50	2.70	16.70	6.60	6.40	8.20	22.30	17.60	7.10	19.80	12.10
Neutrophils X $10^3/mm^3$	7.10	2.00	10.50	3.30	3.90	-	10.40	4.80	1.70	5.60	17.80	14.80	5.70	13.50	9.70
Lymphocytes X $10^3/mm^3$	5.20	0.80	3.80	3.10	0.60	-	5.80	1.80	4.50	2.00	1.30	1.80	1.10	5.90	2.20
Monocytes X $10^3/mm^3$	0	0	0	0	0	-	0	0	0	0	2.50	0	0	0	0
Eosinophils X $10^3/mm^3$	0.60	0.10	0.30	0.20	0.05	-	0.50	0	0.10	0.70	0	1.10	0.30	0.40	0.20
Basophils X $10^3/mm^3$	0	0	0	0	0	-	0	0	0	0	0.70	0	0	0	0
Mean cell volume (μm^3)	94	83	87	79	79	74	82	81	75	69	77	76	76	70	71
Mean cell haemoglobin concentration (%)	31.2	31.6	33.7	33.0	38.0	34.0	36.6	35.0	34.0	34.4	33.3	34.8	34.8	32.0	35.0
Total protein (g/100 ml)	6.5	5.6	5.2	6.4	7.0	6.2	11.0	7.6	5.5	7.0	8.0	8.4	6.0	6.2	6.4

APPENDIX TABLE ; A 15

SERUM BIOCHEMICAL ANALYSIS OF FREE-LIVING JACKALS IN NAROK AND KAJIADO DISTRICTS

PARAMETER	JACKAL NUMBER											
	1	2	3	5	8	9	11	12	13	29	30	31
Urea nitrogen (mg/100 ml)	37	35	28	75	75	60	15	40	10	75	50	75
Phosphorus (mg/100 ml)	-	4.48	3.83	-	-	-	-	3.74	-	4.65	4.65	3.78
Calcium (mg/100 ml)	-	9.50	7.91	-	-	-	-	6.20	-	-	9.04	5.19
Alkaline phosphatase (King Armstrong units)	-	4.80	4.80	-	-	-	-	5.35	-	6.00	6.47	6.00
Serum glutamic phosphoric transaminase (Reitman Frankel units)	-	14.7	18.7	-	-	-	-	13.0	-	12.0	30.0	20.0
Total protein (g/100 ml)	6.20	6.75	4.60	-	-	-	7.00	5.50	7.25	6.00	6.10	5.10
Albumin (g/100 ml)	2.90	2.85	2.35	-	-	-	3.40	4.00	4.60	3.25	3.70	3.60
Globulin (g/100 ml)	3.30	3.90	2.25	-	-	-	3.60	1.50	2.65	2.75	2.40	1.50
Albumin/Globulin ratio	0.84	0.73	1.05	-	-	-	0.95	2.66	1.74	1.18	1.54	2.40

APPENDIX TABLE ; A 16

HAEMATOLOGICAL FINDINGS IN CROSS-BRED DOG A. INFECTED WITH *EHRLICHIA CANIS* FROM JACKAL NUMBER 30

PARAMETER	DAYS POST INOCULATION						
	Day 5	Day 7	Day 9	Day 12	Day 14	Day 19	Day 21
Packed cell volume (%)	30	31	32	32	34	36	37
Haemoglobin (g/100 ml)	9.8	10.1	9.9	10.5	10.3	11.4	11.4
Platelets X $10^3/mm^3$	Normal	286	183	-	-	-	-
Leucocytes X $10^3/mm^3$	9.2	13.1	9.8	12.5	14.0	11.1	9.9
Neutrophils X $10^3/mm^3$	6.3	8.6	7.0	5.0	7.6	5.1	4.5
Lymphocytes X $10^3/mm^3$	2.7	3.9	2.5	6.8	3.9	4.9	4.9
Monocytes X $10^3/mm^3$	0	0.5	0.1	0	0	0	0
Eosinophils X $10^3/mm^3$	0.2	0	0.2	0.8	2.5	1.1	0.6
Urea nitrogen (mg/100 ml)	-	10	15	10	10	20	10
Phosphorus (mg/100 ml)	-	-	7.3	5.9	7.0	8.9	6.8
Alkaline phosphatase (King Armstrong units)	-	-	15.4	20.0	13.5	-	24.7
Serum glutamic phosphoric transaminase (Reitman Frankel units)	-	-	8	37	14	-	11
Total protein (g/100 ml)	-	4.50	6.10	5.60	5.75	5.10	6.25
Albumin (g/100 ml)	-	3.15	4.00	4.15	3.70	4.00	3.60
Globulin (g/100 ml)	-	1.35	2.10	1.45	2.05	1.10	2.65
Albumin/Globulin ratio	-	2.32	1.91	2.86	1.80	3.63	1.35

APPENDIX TABLE : A 17

HAEMATOLOGICAL FINDINGS IN CROSS-BRED DOG B. INFECTED WITH *EHRLICHIA CANIS* FROM JACKAL NUMBER 29

PARAMETER	DAYS POST INOCULATION						
	Day 5	Day 7	Day 9	Day 12	Day 14	Day 19	Day 21
Packed cell volume (%)	28	28	30	31	30	32	33
Haemoglobin (g/100 ml)	8.9	8.9	9.2	9.6	9.0	9.8	10
Platelets X $10^3/mm^3$	Normal	196	242	-	-	-	-
Leucocytes X $10^3/mm^3$	12.4	1.9	5.0	17.1	25.7	15.5	14.6
Neutrophils X $10^3/mm^3$	11.4	-	2.0	13.7	22.4	14.0	9.9
Lymphocytes X $10^3/mm^3$	1.0	-	2.9	3.4	2.6	1.5	4.2
Monocytes X $10^3/mm^3$	0	-	0.1	0	0.5	0	0.3
Eosinophils X $10^3/mm^3$	0	-	0	0	0.3	0	0.1
Urea nitrogen (mg/100 ml)	-	15	15	20	10	-	10
Phosphorus (mg/100 ml)	-	-	6.75	5.35	8.00	-	7.20
Alkaline phosphatase (King Armstrong units)	-	-	14.0	15.5	11.3	-	26.0
Serum glutamic phosphoric transaminase (Reitman Frankel units)	-	-	4.5	3.0	10.0	-	10.0
Total protein (g/100 ml)	-	4.65	-	6.10	6.10	5.60	6.10
Albumin (g/100 ml)	-	3.25	-	4.25	4.00	4.25	3.60
Globulin (g/100 ml)	-	1.40	-	1.85	2.10	1.35	2.50
Albumin/Globulin ratio	-	2.32	-	2.29	1.90	3.14	1.44

APPENDIX TABLE : A 18

HAEMATOLOGICAL FINDINGS IN THE CROSS-BRED CONTROL DOG - A LITTER MATE TO DOG A AND DOG B

PARAMETER	Day 5	Day 7	Day 9	Day 12	Day 14	Day 19	Day 21
Packed cell volume (%)	30	31	32	33	34	37	38
Haemoglobin (g/100 ml)	9.8	10.2	10.3	11.0	11.2	11.9	11.8
Platelets X $10^3/mm^3$	Normal	Normal	-	-	-	-	-
Leucocytes X $10^3/mm^3$	10.5	13.6	15.1	18.2	16.3	10.4	13.0
Neutrophils X $10^3/mm^3$	8.5	9.1	11.9	16.0	13.0	5.8	7.7
Lymphocytes X $10^3/mm^3$	2.0	3.3	2.9	2.2	2.6	4.4	4.9
Monocytes X $10^3/mm^3$	0	0.6	0	0	0	0.2	0
Eosinophils X $10^3/mm^3$	0	0.6	0.3	0	0.7	0	0.4
Urea nitrogen (mg/100 ml)	-	10	10	10	10	20	10
Phosphorus (mg/100 ml)	-	-	5.6	7.5	8.4	-	7.1
Alkaline phosphatase (King Armstrong units)	-	-	15.0	17.9	17.4	-	16.5
Serum glutamic phosphoric transaminase (Reitman Frankel units)	-	-	6.0	20.0	3.5	-	10.0
Total protein (g/100 ml)	-	4.60	5.10	5.25	5.30	5.05	5.25
Albumin (g/100 ml)	-	3.60	4.00	4.15	3.90	3.90	4.00
Globulin (g/100 ml)	-	1.00	1.10	1.10	1.40	1.15	1.25
Albumin/Globulin ratio	-	3.60	3.60	3.77	2.79	3.39	3.20

APPENDIX TABLE ; A 19

TICK SPECIES FOUND ON FREE-LIVING JACKALS IN NAROK AND KAJIADO DISTRICTS

	Rhipicephalus sanguineus	*Rhipicephalus simus*	*Amblyomma* nymphs	*Amblyomma variegatum*	*Haemaphysalis leachi*
Jackal 1		x	x		x
Jackal 3		x	x		
Jackal 5		x	x		x
Jackal 6			x		x
Jackal 7		x	x		x
Jackal 8	x			x	
Jackal 9			x		x
Jackal 10	x	x			x
Jackal 12	x	x			x
Jackal 13	x	x			x
Jackal 29	x				x
Jackal 30					x

APPENDIX TABLE ; A 20

TICK SPECIES FOUND ON MASAI AND TURKANA OWNED DOMESTIC DOGS IN NAROK AND TURKANA DISTRICTS

	Rhipicephalus sanguineus	*R. simus*	*R. appendiculatus*	*R. pulchellus*	*Amblyomma* nymphs	*A. variegatum*	*Haemaphysalis leachii*
Narok Dog 1	X		X			X	
Narok Dog 2	X		X			X	X
Narok Dog 4							X
Narok Dog 5	X						
Narok Dog 6	X						X
Narok Dog 7		X					X
Narok Dog 8	X	X	X				X
Turkana Dog 1				X			
Turkana Dog 2					X		