Bacterial diseases of dromedaries and bactrian camels

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Summary: The literature on bacterial diseases of camels is reviewed, with special reference to anthrax, brucellosis, haemorrhagic septicaemia, plague, salmonellosis, tuberculosis, paratuberculosis, leptospirosis and clostridial infections.

KEYWORDS: Bactrian camel - Bacterial diseases - Camels - Dromedary - Reviews.

INTRODUCTION

Verses 17 and 18 of Sura LXXXVIII (Al-Gashiya, or the overwhelming event) in the Holy Koran read, "Do they not look at the camels, how they were created? And at the sky, how high it was raised?" Sven Hedin, the great explorer of Asia who travelled on camel’s back across the arid deserts of Central Asia, praised the majestic deportment of a particular male camel: “He carried his head with a solemn gravity and his quiet eye searched the horizon with an expression intimating that he felt he was the unlimited and sovereign master of all the deserts of Asia”. The camel, unlike any other animal, is associated with an extraordinarily rich vocabulary in Arabic poetry and lexicography. Despite an inferiority complex in certain camel-breeding countries where an interest in the camel is seen as a return to an old, primitive and backward civilisation, the camel has a privileged role in the arid and semi-arid regions. The recent menace of desertification stands as a good example. Apart from serving as a mount and a means of transport, the camel is a potentially rich source for nomads and bedouins of a large part of their food, clothing and shelter.

The camel is often said to be ignored and neglected, particularly in regard to research and development programmes. To my mind this is a matter of coordination. The existence of a specialised body for camel studies would bring together many fragmented efforts, and a great deal of work already done would then receive attention.

Nevertheless, the camel — which in this review stands for both the two-humped bactrian camel and the dromedary, the single-humped Arabian camel — is susceptible, in its natural habitat, to a number of diseases. This review is confined to bacterial diseases.

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Anthrax

The disease is well-known to nomads and camel breeders, hence the many local names and synonyms given to it by nomads and camel breeders in many countries. Excluding some of the parasitic diseases such as trypanosomiasis and mange, anthrax may be the most serious bacterial disease affecting camels. It is caused by *Bacillus anthracis* and takes an acute or a peracute form leading to sudden death, with or without clinical manifestations. Infection takes place mostly through the alimentary tract, by ingesting contaminated food or drinking from stagnant water. It can also be transmitted directly by biting flies, e.g. *Tabanus* species or nasal bots (*Cephalopina titillator*).

Painful swellings sometimes develop at the throat, the base of the neck and groins. These are particularly large when the palate becomes involved due to a local puncture in the nasopharynx by bots or other means.

The clinical signs, when noticed, may be summarised as: dark foamy blood oozing from the natural orifices, occasional diarrhoea, tympany, colic and apoplectic manifestations.

Camels can be immunised passively or actively by using hyperimmune serum, vaccine or both. Suspected cases, even slaughtered, are a health hazard to man. Infected carcasses have been responsible for spreading the disease in zoological gardens.

Brucellosis

The disease in camels was first recognised in Russia in 1931 and it was summarised in the *Veterinary Bulletin* in 1951. The disease as a whole was well discussed by Rutter and Mack in 1963 (98). Since then, regular reports have been received from a number of countries. In Egypt, Zaki (118) considered camels to be relatively highly susceptible to *B. abortus*, despite his failure in one experiment to demonstrate the organism in milk samples. This work was followed by serological investigations on brucellosis carried out by Hamada *et al.* (47) when 10-20% of Egyptian camels were reactors.

In Ethiopia, 977 serum samples from certain provinces resulted in 43 (4.4%) positive results in the slow agglutination test at a dilution of 1/20 or higher, while only nine were positive at a dilution of 1/80.

In 1975, 315 apparently normal camels in India were tested for brucellosis by the standard tube agglutination test (STT) and the heat-inactivation test (HIT). The disease was diagnosed in 6 (1.8%). In 1978, a serological survey of the disease was carried out in the north-eastern province of Kenya by Kagunya *et al.* (54) and Waghela *et al.* (115). The latter reported a reactor rate of 14% in Kenyan camels. The complement fixation test has proved to be more specific than the agglutination and allergic tests for the diagnosis of brucellosis in camels.

Bohac *et al.* (17) studied the efficacy of "allergen F" (Kalarov) in the diagnosis of the disease in Mongolian camels. The disease was also studied in Mongolia by Tserendash *et al.* (113). In 1974, tests were carried on 54,673 camels by Shumilov (106) in six regions of Mongolia. 3.7% reacted to the CF test and only 1% to the agglutination test. It was necessary to use both tests because the camels in infected herds reacted only to the agglutination test.
In a survey of brucellosis in Kano, Nigeria, 232 slaughtered camels were tested by Okoh (80), with 7 positive in the Rose Bengal plate test and 6 in the tube agglutination test.

In the Sudan, Mustafa et al. (77) carried out a preliminary survey of brucella antibodies in the serum of Sudanese camels, while Hussein et al. (50) provided a veterinary conference in 1975 with details of the incidence of brucellosis in camels in Kordofan province.

In Tunisia, 135 milk samples from Tunisian camels were tested by Burgemeister et al. (18). They were all negative for brucellosis. Of 52 serum samples tested, three had antibodies for \( B. \text{abortus} \), while two others had antibodies for \( B. \text{melitensis} \).

In the Soviet Union, \( B. \text{abortus} \) has been accepted as the usual causal agent in camels since 1931 (107). Rutter and Mack (98) referred to various Russian work on the control of the disease. According to Solonitsyn and Pal’gov (108), resistance to the disease was low at the age of 7 to 8 months, and it was important to remove young camels from reactor dams. Ostrovidov (84) considered young camels to be resistant up to the age of 11 months, after which they were likely to contract the disease from infected dams at the next parturition.

The disease, in general, is not accompanied by clear-cut symptoms, and spontaneous recovery is possible except in some cases of subacute infection (84).-abortion usually coincides with a high incidence of serological reactors, but it is not a constant symptom.

Using brucellin (prepared from \( B. \text{abortus, melitensis and suis} \)), abortin (\( B. \text{abortus} \) only), the agglutination test and the complement fixation test, Solonitsyn (107) found that the best results were given by the complement fixation test. According to Pal’gov (86), the best results were given by the complement fixation test combined with intradermal brucella lysate. Further work was done by Chichibabin (21) who studied the disease in camels, particularly various serological tests, and the use of heated serum for the agglutination test.

**Haemorrhagic septicaemia**

*Pasteurella multocida* infection has been reported in a number of countries including Algeria, Egypt, India, Iran, Libya, Mauritania, North Africa, Somaliland, Soviet Union, Sudan and Chad. As in the case of certain other diseases, a lot of work is needed to determine the exact picture of the disease, which probably still occurs sporadically, particularly in some of the camel-breeding countries for which no reports are available.

Cases are very often confused and mixed with other diseases such as anthrax and salmonellosis (33), and diagnosis requires proper bacteriological examination. In his “Tips” on camels, Leese (63) referred to Gaiger and added his own experience to conclude that haemorrhagic septicaemia had no effect upon camels unless they were stressed or sufficiently debilitated by another disease such as trypanosomiasis. Gaiger’s work was also referred to by Cross (23). Camels which have recovered possess strong resistance to the causal agent of bovine haemorrhagic septicaemia. An attenuated form of the organism was recovered from the internal organs 31 days after inoculation; neither a local nor a general reaction was noticed in the inoculated animals.
This differed from the findings of Cross (23) whereby inoculation of cultures was followed by transient fever and a swelling at the site of inoculation, but no other systemic symptoms.

Nevertheless, the disease is mostly acute and accompanied by fever, shivering, dullness and subcutaneous swellings in the pharyngeal and prescapular regions. The latter may be extensive and followed by gastroenteritis, abortion in females and possibly death. Donatien and Larrieu (34) reported fever lasting for a few days with inappetence; in some other cases, pneumonia, generalised myositis and diarrhoea were seen. Donatien (32) described an outbreak involving 10% of the camels and a mortality rate reaching 50%.

**Camel plague**

Sotnikov (110) described the disease as a typical example of evolution from an infection originally confined to wild rodents. It is zoonotic and caused by *Pasteurella pestis*. Its importance has greatly diminished in recent years, despite the presence of foci in Mongolia, China, India, Iran, Iraq, USSR and many other countries in Africa and North and South America. In Algeria, Martynchenko (71) described the clinical picture of plague in camels infected by means of ectoparasite carriers. The disease is readily transmitted by fleas. The incubation period varies from one to six days, usually ending in death within twenty days. As mentioned by Rutter and Mack (98), camel plague associated with human infection was first reported in Russia by Kowalevsky (58) and the last case was in 1926 as mentioned by Strogov (112). They also quoted Sacquépée and Garcin (100) who considered that African camels were susceptible to plague, and could develop the bubonic type of the disease with abscesses in lymph nodes and elsewhere; the organism was isolated from such lesions and pleural exudate. Korobkova (57) was also cited by Strogov (112) as having prepared an anti-plague serum in camels and tested a dried live vaccine which produced good immunity after a single dose of $30 \times 10^9$ organisms.

Labanov (67) inoculated ten camels intradermally and one camel subcutaneously with 1,000 to 52,000 million *P. pestis* organisms, and slaughtered them 13 to 48 days later. Mild fever developed and subsided in two to three weeks. Small, rapidly healing abscesses developed at the site of inoculation. Subcutaneous lymph nodes all over the body were affected by acute or subacute purulent or non-purulent inflammation. Two camels which received the highest dose became emaciated and were slaughtered, while six others had haemorrhage in the serous membranes and dystrophy in the parenchymatous organs.

Fedorov (44) refers to the relatively low susceptibility of camels to infection transmitted by ticks which was transferred from infected laboratory animals.

**Salmonellosis**

The disease was first referred to by Kowalevsky in 1912 (58) as part of a description of infectious enteritis of camels occurring in humid zones of Russia. A similar enteric type in the Sudan was described by Curasson (24). In 1947, Curasson (27) also described an outbreak in camels kept near stagnant water during the dry season in the Sudan. The disease was first recorded in Palestine in 1940 by Olitzki and Ellenbogen (82), who isolated a *Salmonella* strain with antigenic characteristics resembling those of *S. kentucky*. Three strains of *S. kentucky* were later isolated by Olitzki in 1942 (81).
In French North Africa, Donatien and Boué (33) reported an outbreak of the disease in low-lying territory where water had become polluted with faeces. It was characterised by septicaemia, enteritis and abortion. A *Salmonella* strain was isolated from the blood of one camel and the long bones of three others. 1,500 out of 7,000 camels died in the outbreak; other animals were not involved.

The disease has since been reported by various authors in Egypt, India, Somalia and the Sudan. In Tunisia, Burgemeister et al. (18) failed to detect antibodies to *Salmonella* in serum samples from 52 camels. In India, *Salmonella* serotypes were studied by Malik et al. (69). They isolated 19 *Salmonella* strains of nine serological types from 410 faecal samples from apparently healthy camels. Ambwani and Jatkar (7) studied the sensitivity of *Salmonella* strains to various antibiotics. In 1973 they isolated *Salmonella* from 14 of 271 faecal samples; ten of these were found to be *S. typhi* while the other four could not be typed (8).

**Tuberculosis**

The disease was first reported in Egypt by Littlewood in 1888 (66). This was followed by the findings of Archibald (11) who isolated acid-fast organisms from lung lesions resembling miliary tuberculosis. The work of Mason (72-74) helped to clarify the position of the disease in Egypt. The disease was apparently rare among the camels of nomads, whereas it tended to occur among camels kept for farming and in close proximity to cattle. The incidence of camel tuberculosis in Egypt along with typing of the causal agent was reported by El-Afifi *et al.* (37). This was followed by an examination of 1,809 camel carcasses at Cairo abattoir carried out by Elmossalami *et al.* (39) who found six aged males and one aged female with tuberculous lesions in various organs. These were of the productive proliferative type while some were calcified. The small number of giant cells present was the main difference from the reaction in other ruminants.

Camel tuberculosis in India was first mentioned by Lingard (65) and then by Leese (61-63), who considered it to be comparatively rare, except in old camels where the usual pulmonary form and occasionally a generalised form were not uncommon. Persistent heamaturia was noticed by Cross (22). The disease was referred to by Damodaran *et al.* (28).

Information from other camel-breeding countries is scanty. The disease was reported in Ethiopia by Richard (96), and a spontaneous case of camel tuberculosis in Somaliland has been described by Pellegrini (89). It was characterised by progressive debility, coughing and death within six months. Caseous nodules were found in the lungs, liver, spleen and lymph nodes. Granulomatous masses with caseation were present in mediastinal lymph nodes, and grape-like lesions in the pleural cavity. The organism was believed to be a virulent strain of the bovine type, pathogenic for guineapigs, rabbits, sheep and calves.

In countries where camels are housed in close proximity, the disease is similar to that reported from the Soviet Union, where Donchenko *et al.* (36) isolated seven strains of *Mycobacterium bovis* from 46 bulked samples of raw milk from 712 lactating camels in three intensively-farmed herds. The organism could be destroyed by heat treatment of the milk. Sixty-five reactors were revealed by tuberculin testing. Seven reactors were slaughtered. Typical tuberculous lesions were seen in two cases while the other five cases showed no lesions. The disease was also reported by Abramov
(2-4) who dealt with its diagnosis, pathology and the susceptibility of camels to the various types of tubercle bacilli. While Fedchenko (43) referred to the epidemiology of the disease and the haematological changes, Kagramonov (53) dealt with its microbiology in the USSR during a period of sixty years. Urazakov et al. (114) dealt with what was claimed to be the first report of the treatment of human pulmonary tuberculosis with “shubat” (fermented camel’s milk).

Limited information is available on camels kept in circuses and zoos. Open tuberculosis in circus camels due to *Mycobacterium bovis* was described by Dekker et al. (29).

**Paratuberculosis (Johnne’s Disease)**

The literature on this disease in camels is rather scanty. The work of Ivanov et al. (52) and Strogov (111) has clarified the general picture. Strogov (111) refers to the disease in Turkmenistan where it had been known since 1949. Though rare in younger camels, its frequency was highest in camels between 2 and 3 years of age. Early weaning in summer did help to enhance resistance. From 1946 to 1952 the annual incidence varied from 0.3-1.54% of all camels, the incidence being highest in the winter-spring period. Sheep in contact with infected camels did not contract the disease. In the double intradermal tuberculin test, 40% of the camels gave a positive reaction to avian tuberculin. 600 positive and doubtful reactors showed no acid-fast organisms in smears of faeces and rectal mucosa. No evidence of Johnne’s disease was observed when seven reactors were slaughtered.

Ivanov et al. (52) were of the opinion that the disease was fairly common in camels in USSR. Lesions were generally more severe than those in cattle, with fatalities after 4-6 weeks of illness. Lesions were most frequent in the ileum, caecum and colon, and were usually accompanied by inflammatory changes in the liver, spleen and lymph nodes.

The disease was detected serologically in Tunisia by Burgemeister et al. (18) who showed that 11 of 52 serum samples had antibodies to *Mycobacterium paratuberculosis*. A report on the disease was given by Amand (6). It is noteworthy that relevant research is still being done in camel-breeding countries.

**Leptospirosis**

This is another disease for which the literature is rather scanty as far as the camel is concerned. In Algeria, cattle were the only species thought to be affected (16). However, there have been some positive reports. Krepokogorskaya (59) reported bacteriological and serological diagnosis of leptospirosis in cattle, horses and camels belonging to the Experimental Breeding Station of Betpak-Dal, USSR; the species demonstrated were *L. kazakhstanica I, L. kazakhstanica II* and *L. vitulina*. Rafyi et al. (92) demonstrated *L. icterohaemorrhagiae* antibodies in an Iranian female camel that developed haematuria and aborted a week later.

In Somaliland, Farina and Sobrero (41) demonstrated agglutinating antibodies in 11 of 61 camels, representing *Leptospira* serovars: *icterohaemorrhagiae, canicola, grippotyphosa* and *ballum*. Burgemeister et al. (18) found 25 of 52 samples from Tunisian camels to possess antibodies to *icterohaemorrhagiae, pomona* and *bataviae*. In a serological survey undertaken between 1968 and 1971 among domestic animals and man in Egypt, Maronpot and Barsoum (70) found leptospiroagglutinin titres of 1:128.
and greater in 17 of 50 camel sera tested. It was concluded that subclinical leptospirosis is not a rare disease in Egypt and may well constitute a significant public health hazard.

In their first survey of leptospirosis in Afghanistan, Sebek et al. (104) revealed *grippotyphosa* antibodies in a dromedary, while Sebek (102) found one of 131 camels to possess agglutinins to a range of ten leptospiral serogroups. This work was extended by Sebek et al. (103) who investigated the serological picture of leptospirosis in Afghanistan.

In Sudan, a serological survey for leptospirosis in animals was carried out by Shigidi (105), but the samples from 55 camels were negative.

### Clostridial infections

Several members of the genus *Clostridia* are responsible for important diseases in man and animals. As far as the camel is concerned, the limited information available makes it difficult to assess the real situation.

1. **Black quarter** due to *Cl. chauvoei* is very often confused with anthrax, particularly when there are extensive swellings at the base of the neck. Cross (23) reproduced the disease in three camels by intramuscular inoculation. This was followed by initial lameness, fever and a swelling at the site of inoculation which rapidly increased in size and became emphysematous, distinguishing it from anthrax. These symptoms ended with difficult respiration, grunting and a rapid fall in temperature, resulting in death within 3-4 days.

   The disease is known to occur in Algeria, but it may be confused with anthrax. It has also been reported in Chad, India and North and East Africa. Tarantino (1934; cited in 98) described the disease in Somaliland as being characterised by swelling of the axilla or the base of the neck. He referred to it by the Somali name “Kud”, which is the name for anthrax (64).

2. **Tetanus** is rather rare in camels. Leese (63) referred to its occurring as a result of bites, sores or shell wounds. Affected camels were incapable of assuming a sitting position; recovery was rare. Ramon and Lemétayer (95) found titres of tetanus antitoxin in the blood of camels as high as in sheep and goats, but lower than in zebu in the same area.

   Other clostridial affections are very rare in camels, but Ipatenko (51) referred to *Cl. perfringens* types C and D as being responsible for infectious enterotoxaemia. This organism is widely distributed in soil and in the intestinal tract of animals. The spores are heat-resistant and are killed only by boiling for 90 minutes.

   Clostridial enterotoxaemia was mentioned by Ipatenko (51) as occurring in the acute and subacute forms in Gobi (Mongolia) and in countries of Arabia, equatorial Africa and Latin America. The symptoms included excitement, running, staggering and convulsions before sudden death. Sometimes the excitement stage ended with coma and recumbency for several hours or days followed by death. Subacute cases were characterised by diarrhoea and death within twenty days. In Chad, Provost et al. (91) described the first case of botulism in camels due to *Clostridium botulinum* type C.

### Bacterial pulmonary affections

These usually develop as a consequence of fatigue, cold weather, debility and other ailments such as trypanosomiasis. To prevent potential contagion, Leese (63) used
to segregate cases of pneumonia among adult camels. Pneumococci have been referred to in Egyptian camels since 1929, and pneumonia as such was described by Farrag et al. (42a). In India, Klebsiella pneumoniae and diplococci were isolated by Arora et al. (12) from cases of bronchopneumonia in camels. Different types of bacteria were also isolated by Shigidi (105) from the nasal tract, lungs and bronchial lymph nodes of 64 apparently healthy Sudanese camels.

There is a need to conduct further research on bacterial affections of the lungs and also to distinguish them from those caused by other infectious agents. Reports are still appearing of single, isolated cases, e.g. a pulmonary abscess in a camel in Mali (46). Leese (63) referred to an infectious catarrh which should be distinguished from the clear nasal discharge associated with the emergence of camel botflies from the nasopharynx.

In the Gobi desert of Mongolia, approximately 50% of the camels affected with contagious cough die (78). Symptoms consisted of a rapid rise in temperature to 41.5-42°C, thirst, reduced appetite, enlarged lymph nodes and often lameness of the hind legs. The disease lasts up to two months. Post-mortem examination revealed lymphadenitis, fluid in thoracic and peritoneal cavities and catarrhal inflammation of the gastrointestinal tract. Haemolytic encapsulated pneumococci were isolated and found to be virulent for guinea pigs, mice and calves. Oinakhbaev (79) failed in his attempts to isolate a virus or rickettsia from affected camels. An encapsulated pneumococcus ("Pneumococcus cameli") was present and proved to be pathogenic for guinea pigs, mice and calves (but not rabbits, lambs or piglets). The organism was capable of reproducing contagious cough in camels.

Other bacterial affections are rather scanty in the available literature, but this should not deter research workers from looking for them. Corynebacterium pseudotuberculosis has been isolated occasionally in association with actinomycotic infections. The organism was isolated from a camel in Iran by Esterabadi et al. (40) and by Rak and Rahgozar (93). The infection was referred to as pseudo-actinomycosis by Mason in 1920 (75).

Staphylococci are widespread in nature and occur as a normal inhabitant of the skin. They may infect wounds and be present in cutaneous abscesses and lesions. A good example is "contagious skin necrosis" which is widespread in Egypt, India, Somaliland and Sudan. The disease is characterised by necrotic lesions of the skin and abscesses in various parts of the body where staphylococci and streptococci prevail as contaminants and a complicating factor rather than causal agents. Streptococci have been considered responsible for abortion in camels (88).

Staphylococci are responsible for mastitis in the camel. Kospakov (57a) isolated 87 strains of staphylococci from the udder tissue of camels, 16 from bulk milk, 3 from milkers' hands and from udder skin. In India, Kapur et al. (54a) recorded a case of peracute mastitis caused by Klebsiella species and E. coli. This infection was contracted after a surgical operation at a veterinary college. It may be an atypical case, not reflecting natural affection in the field. Staphylococci are responsible for "botryomycosis" or granulomatous staphylococcal mastitis, and also for the staphylococcal granuloma complicating "sore back". The latter may require surgical excision.
CONCLUSION

This review of the bacterial diseases of camels demonstrates that many aspects require further study. The bactrian camel is readily accessible when kept in intensive farms, thus providing an opportunity for research work. On the contrary, the dromedary mostly roams in the desert, and so requires study by means of mobile laboratories and research workers who accept nomadism for a time. Perhaps a camel research centre could be established for this purpose, located in the centre of a nomadic area, where camel caravans are abundant and national experts are available. Provision of such a facility would require collaboration between organisations which have camel and human interests in mind.

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LES MALADIES BACTÉRIENNES DU DROMADAIRE ET DU CHAMEAU. — I.E. Mustafa.

Résumé : L'auteur fait une revue bibliographique des publications consacrées aux maladies bactériennes du dromadaire et du chameau. Il présente plus spécialement le charbon bactérien, la brucellose, la septicémie hémorragique, la peste, la salmonellose, la leptospirose et les infections clostridiales.


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LAS ENFERMEDADES BACTERIANAS DEL DROMEDARIO Y DEL CAMELLO. — I.E. Mustafa.

Resumen: El autor lleva a cabo una revisión bibliográfica de las publicaciones dedicadas a las enfermedades bacterianas del dromedario y del camello. Se refiere en particular al antrax, la brucelosis, la septicemia hemorrágica, la peste, la salmonelosis, la tuberculosis, la paratuberculosis, la leptospirosis y las infecciones clostridiales.

PALABRAS CLAVE: Camélidos - Camello - Dromedario - Enfermedades bacterianas - Revista bibliográfica.

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