

Mysterious mortality in camels (*Camelus dromedarius*) in Borana, Ethiopia: evidence of its association with reproductive age groups

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Summary

In May and June of 2007, sudden death was observed in camels in southern pastoral areas of Oromia, Ethiopia. It significantly ($p < 0.001$) affected reproductive age groups of both male and female camels (in females and males, 63.9% and 10.8% of those in reproductive age groups were affected, respectively). Pregnant females (37.6%) were affected significantly more often ($p < 0.001$) than non-pregnant females. Absence of rigor mortis and absence of blood clotting, together with the death of pregnant and lactating camels, were common findings during different outbreaks, but no aetiological agent such as *Bacillus anthracis* was isolated. In addition to loss of milk in lactating camels and loss of the calf in pregnant individuals, the average value of the dead camels was 2377.6 birr (~US\$264). A multifactorial cause of mortality is hypothesised. Hence, research to develop an intervention, with increased input of financial resources and time, is required urgently so that the cause of the problem can be discovered and the disease can be controlled.

Keywords

Camel – Ethiopia – Multifactorial cause – Reproductive age group – Sudden death.

Introduction

The world's camel population has been estimated at almost 23 million, and more than 95% of camels are found in developing countries (15). Approximately 2 million camels are found in Ethiopia (7), of which around 1 million are kept in the southern pastoral area. All camels in Ethiopia are owned by pastoralists. Camel production and/or herding form a part, if not the major part, of the livelihoods of most people of the Somali and Oromia regions of this

area. The Borana zone is one of the 12 zones of the Oromia region and camels were introduced there by Gabra Oromo pastoralists who live in the lowlands of southern Ethiopia (12).

Pastoralism is always associated with risk, because the life of pastoralists is based on unreliable climatic conditions, border and marginal lands, recurrent drought, livestock disease epidemics, conflicts, etc. (20). During drought conditions, camels are the animals least affected and they can continue to be a reliable means of transport; hence,

they are known as the 'ships of the desert'. Like cattle, they provide a variety of resources (including milk, meat and hides), they are a form of investment, and they play an important role in pastoralist culture. They sustain the life of pastoralists in these harsh environmental conditions because they are the most efficient animals in converting fodder into energy for work and consumable products (milk and meat).

Sudden death of camels was observed in Ethiopia early in 2006 in the Afar region and the Fentale district of the Oromia region in the eastern part of the country (Fig. 1). In 2007, similar outbreaks of massive camel mortality were observed in pastoral areas further south. These outbreaks affected large numbers of camels and required an assessment of the economic impact as well as a risk factor study in order to control future outbreaks by tailoring control measures to the problem. The use of risk factor analysis techniques has increased greatly in recent years, especially in relation to risk management for exotic diseases (13). Where a risk or uncertainty is identified, even if it cannot be quantified, it can usually be prevented

by appropriate controls and monitoring measures (13). The 2007 camel mortality in the Borana zone and neighbouring Guji zone of Oromia regional state affected mainly lactating and pregnant camels, a few breeding males of more than three years of age (9), and some heifers. Many more camels were found dead in other southern pastoral areas from both Oromia and Somali regions. Yet the cause of and/or risk factors for sudden death in camels are not known, and therefore it is difficult to institute appropriate measures.

Investigation of camel diseases and ectoparasites under Ethiopian conditions is not well addressed, except for a few fragmented reports on camel trypanosomosis and mange mites (17), cephalopsis and helminthoses (1), ticks (4), camel pasteurellosis (5) and peste des petits ruminants (PPR) (2, 22). Recently, Samuel (24) reported causes of lung lesions in camels from the eastern part of Ethiopia. In Borana, Gebre *et al.* (11) reported the presence of different types of ticks and trypanosomosis. Rufael (23) has reported 'furro', a disease condition of unknown aetiology that is manifested by discharge from the eye and

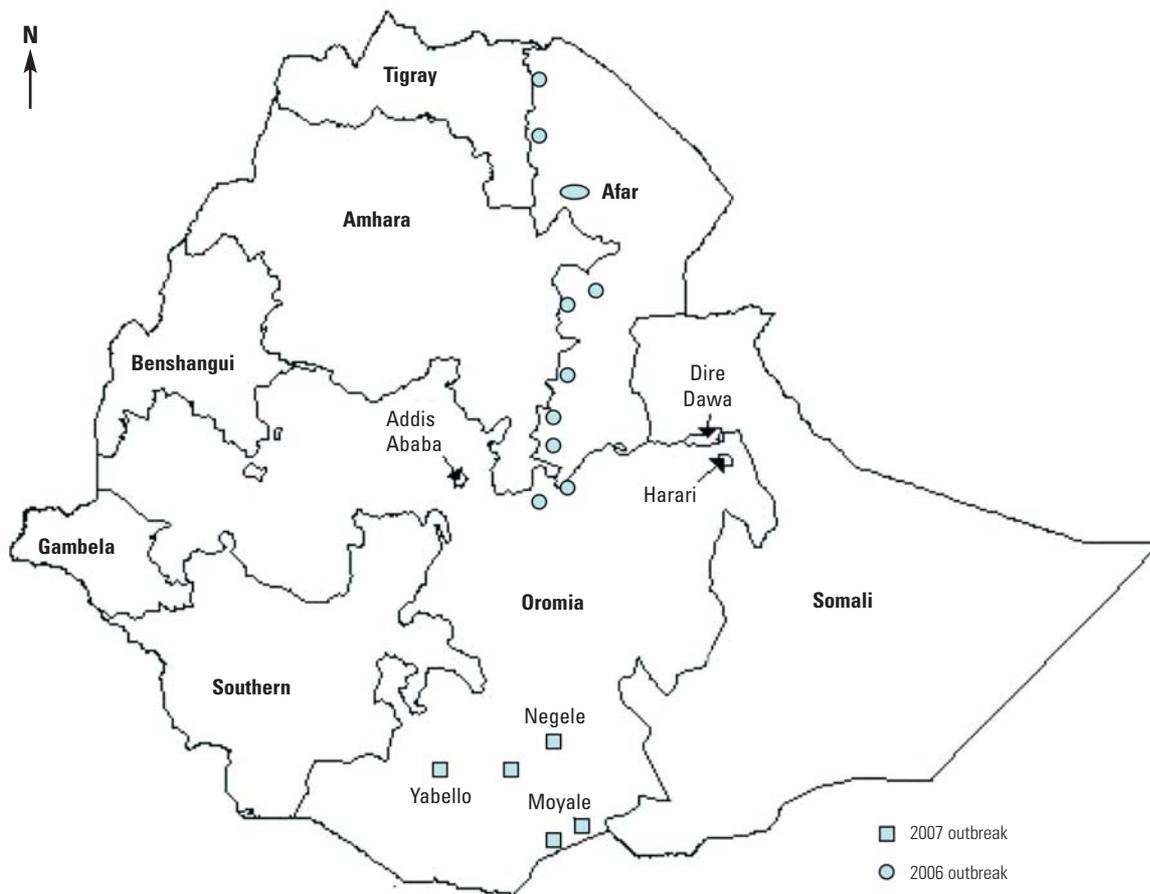


Fig. 1
Areas involved in the outbreak of sudden camel mortality in Ethiopia in 2006 and 2007
 All the boundaries are unofficial and approximate

mucopurulent nasal discharge in camels. The condition is most probably caused by PPR, which was observed in the eastern pastoral area during the same period (22). The sudden camel mortality reported in Borana in 2007 was new to both professionals and pastoralists and also differed in many respects from that of the mid 1990s (22, 23). Nothing is known about the cause of the disease. Therefore, pastoralists' observations and the results of a questionnaire survey are reported in the hope that they can contribute to the understanding of the sudden camel mortality observed in the southern pastoral area, Borana, Ethiopia.

Materials and methods

The pastoral area of southern Oromia is one of the lowland areas of the southern part of Ethiopia and occupies a total land area of 95,000 km² (6, 26). The altitude ranges from 600 m above sea level (m.a.s.l.) at Teltele to 2,200 m.a.s.l. at Yabello, and the average temperature ranges from 19°C to 35°C. It receives average rainfall that ranges from 400 mm to 760 mm, with short and long rainy seasons.

Data on camel mortality were collected from the Yabello district of Borana, approximately 535 km from Addis Ababa (Fig. 1), at the end of the mortality period, that is, at the end of June 2007. Large numbers of camels died within a short period of around two months. To assess the situation of camel mortality in Yabello at the end of the outbreak, a questionnaire survey was carried out by development workers to address variables including sex and age groups, any clinical signs immediately before and during death, post-mortem findings (if any), and the physiological status of dead camels. Eighty individuals whose camels were found dead were selected purposively and interviewed to generate first-hand information.

Data on herd dynamics in 2003 and 2004, recently reported by Megersa *et al.* (16) from the Borana area, were used as a basis for herd-level calculations and comparison of variables. In addition, the estimated price of the dead camels, based on the market situation in the area when the deaths occurred, was estimated to assess the economic impact of the camel mortality on pastoralists. Out of the 186 dead camels for which data were generated, only 154 were used for estimation of the mean price. The data were analysed both at herd and at animal level with descriptive statistics and chi square (χ^2) analysis using the Statistical Package for the Social Sciences (SPSS) for Windows (Version 12.0). The association between age and occurrence of sudden camel mortality was checked by performing correlation analysis using SPSS.

Results

The mean (\pm standard deviation [SD]) age of the dead camels was found to be 6.5 years (\pm 2.5, range 0.5 to 14) and the frequency distribution of dead camels is indicated in Table I. Reproductive age groups of both male and female camels were the most significantly ($p < 0.001$) affected: in females and males, 63.9% and 10.8% of those in reproductive age groups were affected, respectively. The mean (\pm SD) price of the affected camels was 2,377.60 birr (\pm 379.6, range 1,500 birr to 3,050 birr; US\$1 ~ 9 birr, Table II). Considering all the price data, the calculated mean price was almost equal to the median price (2,500 birr). The differences in age and price observed among dead camels were significant ($p < 0.001$). Camels aged seven (17.2%) and eight years (21.5%) were most commonly affected. The correlation coefficient relating each increment of age (range 0.5 to 10) and the occurrence of sudden death was 0.506. Details of the sudden camel mortality in different age groups are shown in Fig. 2. As a proportion of the number of camels in the same category, the most commonly affected camels were breeding males (> 4 years), followed by pregnant and lactating females (Table I). However, with regard to the total number of camels found dead, the most commonly affected were pregnant and lactating females (Table I).

The post-mortem findings in most outbreak areas of the Borana zone, as reported by pastoralists, were rupture of the pericardial sacs and/or the heart, darkening of the lungs, inflammation of small and large intestines, and frothy gas in some parts of the large intestine. Other findings included yellowish discoloration of internal organs such as the intestines, liver and kidneys. The absence of blood clotting and absence of rigor mortis,

Table I
Distribution of camel mortality from May to June 2007

Category	Number of camels*	Number of dead camels	Percentage mortality	
			Proportion of the number of camels in each category	Proportion of total mortality
Calf (< 2 years)	245	6	2.4	3.2
Young (2-4 years)	267	38	14.2	20.4
Breeding bull (> 4 years)	63	20	31.7	10.8
Lactating	265	49	18.5	26.3
Pregnant	262	70	26.7	37.6
Dry (> 4 years)	65	3	4.6	1.6
Total	1167	186		
Chi-square value			42.8	59.3
Significance			$p < 0.001$	$p < 0.001$

*data taken from Mahdavi (15)

Table II
Estimated prices of 154/186 dead camels, May to June 2007

Price in birr*	Number	Percentage	Cumulative percentage
1,500	4	2.6	2.6
1,600	4	2.6	5.2
1,700	3	1.9	7.1
1,800	5	3.2	10.4
1,900	1	0.6	11.0
2,000	29	18.8	29.9
2,200	1	0.6	30.5
2,250	2	1.3	31.8
2,300	2	1.3	33.1
2,400	1	0.6	33.8
2,500	73	47.4	81.2
2,600	1	0.6	81.8
2,700	9	5.8	87.7
2,800	1	0.6	88.3
2,900	2	1.3	89.6
3,000	15	9.7	99.4
3,050	1	0.6	100.0
Total	154	100.0	

p < 0.001
 * US\$1 ~ 9 birr

together with the death of pregnant and lactating camels were some of the findings that were common to the 2007 outbreak and that occurred in 2006.

Discussion

The sudden camel mortality that affected pastoral areas of southern Oromia in 2007 killed a large number of

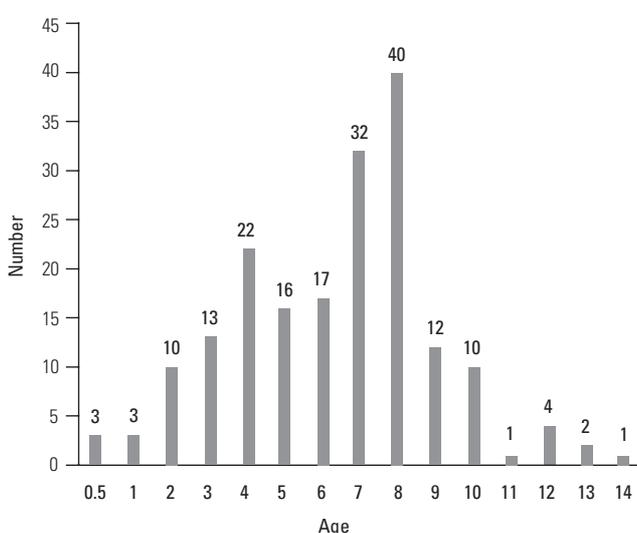


Fig. 2
Mortality of dead camels by age

pregnant and lactating females. This is in agreement with mortality in female camels during drought and El Niño periods in southern Ethiopia (19). However, proportionately more breeding bulls died, which may have been due to the low number of bulls kept by pastoralists for breeding purposes. Bulls that are not intended for breeding are usually sold. The 14.2% mortality rate in young camels is lower than the rates of 23.5% and 63.7% reported from the same area (16) and from eastern Ethiopia (27), respectively, during non-outbreak periods. However, the mortality in dry camels was almost equal to that of a recent report (16).

The mortality observed in camel calves was very much lower than the 17.6% (over two years of study) reported by Megersa *et al.* (16) from the same area. Similarly, Baumann and Zessin (3) also reported 19.6% mortality in camel calves in Somalia. The low calf mortality observed in this study, together with low mortality rates in young and dry camels, suggests that the disease showed clear selection for mature and reproductively active camels.

The youngest age of camels at puberty is four years, as reported from eastern pastoral areas of Ethiopia (17). The mortality in breeding bulls, pregnant and lactating camels indicates that the disease targets reproductive age groups, which suggests a serious impact on the establishment of camel herds using replacement stock. The high mortality in both pregnant and lactating camels has a direct negative effect on the livelihood of pastoralists because they depend on milk from their animals. According to a recent report (16), 75% of camel milk from this area is used for home consumption and the rest for generation of cash income for household expenditure.

If the excess mortality noted in this study had not stopped spontaneously and had not been limited in area, it could have devastated the genetic potential of camels in the area. The mortality targeted reproductively active camels, and even if a few animals in reproductive age groups had survived, it would have taken a long time for the population to recover because camels reproduce slowly (every two years). Restocking of camels would not have been a realistic option because it is not an easy task in comparison to that of sheep, goats and cattle, for clear economic reasons. Hence, the livelihood of pastoralists who depend on camel production would have been jeopardised. Research is still required because the aetiology of the observed syndrome of sudden death is unknown, and these animals are required to sustain the livelihood of pastoralists, especially during periods of drought.

During the mid 1990s, a sudden onset of camel disease in most camel-producing areas of Ethiopia occurred. The clinical signs were: seromucopurulent nasal discharge, lacrimation, productive coughing and dyspnoea coupled with abdominal breathing, and PPR was detected using

molecular techniques (22). In another study, Roger *et al.* (21) reported both PPR (7.8%) and rinderpest (RP) (21.3%) from a total of 90 camel sera collected from three different parts of the country. In 2005, of 628 camel sera collected from different camel-producing areas of Ethiopia, a seroprevalence of PPR of 3% was reported (2). This may suggest the presence of true PPR, or of a very closely related newly emerging morbillivirus that is serologically undistinguishable from PPR and RP (21). However, samples collected from the 2006 outbreak and sent to Iowa in the United States were serologically negative for foot and mouth disease, RP and PPR viruses (Gelagay, personal communication).

Unlike the outbreak in the mid 1990s, the sudden death (peracute disease) observed in camels in 2006 in Eastern Ethiopia and in 2007 in Southern Ethiopia did not allow either professionals or the pastoralists to observe clinical signs. As a result, the presence of PPR virus, which is usually associated with clinical signs, is unlikely. However, experimental evidence of how PPR and RP are manifested in camels is lacking. Wernery *et al.* (25) recently reported a study of equine rhinitis A virus, which targets the upper respiratory tract in horses but causes abortion in camels. What is puzzling about the 2006 and 2007 outbreaks is that there was an absence of uniform and tangible clinical signs, except some post-mortem findings. These findings are in agreement with previous outbreaks of camel mortality reported from Ethiopia and elsewhere (8). Currently, investigation of possible causative viruses is ongoing using a set of universal primers and some primers specific for morbilliviruses (RP and PPR) in an attempt to amplify any viral sequences in samples collected from Borana in 2007.

Information obtained from the Yabello district, the 2007 outbreak area, suggested that the udder of affected pregnant camels increased in size as if the animal was going to give birth very soon, and lactating females gave a higher than usual milk yield before they died. It was also reported that some camels showed neurological signs and vocalised a few minutes before death, and that dead camels showed neck extension. Unfortunately these limited clinical signs reported by pastoralists, and even the laboratory findings, did not provide a clue to the aetiology. This was in agreement with previous reports (9, 10, 14) that suggested that many diseases of camels remain mysterious.

Post-mortem examinations on camels that died in 2006, conducted around the Adami Tullu Agricultural Research Centre, showed nasal discharge of regurgitated material, oozing of a small amount of blood from the anus, and total absence of rigor mortis and blood clotting (Dawo, personal observations). In Fantale in 2006, the same post-mortem findings were observed and samples were also culture negative for anthrax bacillus (Gari, personal

communication). Absence of rigor mortis and absence of blood clotting were some of the findings that were common between the outbreaks that occurred in 2006 and 2007, in addition to mortality of pregnant and lactating camels. The absence of rigor mortis and absence of blood clotting are pathognomonic signs of anthrax. Accordingly, anthrax was suspected but vaccination against anthrax and even mass treatment with broad-spectrum antibiotics did not stop the mortality, although a reduction in mortality was observed. Until the cause of this syndrome of sudden death in camels is identified and confirmed this camel health problem will persist and it will affect the livelihood of pastoralists negatively. In addition, unless *Bacillus anthracis* is isolated and identified from dead camels with an absence of rigor mortis and blood clotting, the two signs will cease to be pathognomonic signs of anthrax, at least in camels.

The issue of camel mortality in Africa and Saudi Arabia was brought to the attention of the international scientific community in the form of two articles which asked the following questions:

- Why are huge numbers of camels dying in Africa and Saudi Arabia? (8)
- Camel scientists ask: what is sinking the ships of the desert? (14).

Despite these efforts, a tangible causative agent has not yet been identified. Fortunately, the 2007 outbreak stopped spontaneously after almost two months.

In addition to the loss of reproductive camels, the loss of milk, loss of calves and stunted growth in young animals will have a cumulative economic effect on the livelihood of pastoralists. Although marketing of camels continued during the outbreak period, few purchases were made in the marketplaces found in pastoral areas of Borana (personal observation). Therefore, any development activities to be undertaken in pastoral areas should consider camel health, including production, breeding and marketing, and the constraints on camel health need to be identified and solved.

Conclusion and recommendation

The outbreak of camel mortality noticed in the southern pastoral area of Ethiopia in 2007 is a true challenge for field veterinarians, animal health researchers and academics as well as the country at large because it targeted the reproductive age groups of camels and had unknown aetiology. The study area undergoes a long rainy season,

during which the mortality was observed, and therefore plant poisoning is unlikely because enough feed was available.

Studies related to diseases of camels in Ethiopia are scarce. The issue of camel mortality needs detailed investigation and laboratory analysis with good financial support and other resource input. Addressing the following points might lead to possible solutions:

- investigation of possible signs of disease immediately, and if possible during an outbreak, by teams of veterinary professionals using detailed participatory epidemiological techniques
- continuous epidemiological investigation on multiple risk factors and/or causative agents to collect epidemiological data before, during and after an outbreak of mortality, which could help to control the outbreaks despite the fact that the causative agent(s) have not been confirmed by laboratory analysis
- investigation of all possible causes of sudden death in camels with particular emphasis on viruses, toxins

produced by bacteria and fungi, and mineral deficiency, especially of selenium, because a temporal pattern of outbreaks has not been identified

- use of molecular techniques relying on random primers to discover new pathogens, because viruses are expected to play a leading role in emerging camel diseases in Ethiopia
- finally, testing of any suspect samples in at least two different laboratories so that the results obtained can be compared and confirmed before a cause-effect relationship is established in camels.

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Mortalité inexpiquée chez le dromadaire (*Camelus dromedarius*) en pays borana, Éthiopie : démonstration d'une corrélation avec l'âge reproductif des animaux

F. Dawo

Résumé

Des cas de mort subite ont été enregistrés chez des dromadaires des secteurs d'élevage pastoral au sud d'Oromia, Éthiopie. Cette mortalité a significativement affecté ($p < 0,001$) les groupes en âge de reproduction, aussi bien chez les mâles que chez les femelles (le pourcentage d'animaux en âge productif affectés était de 10,8 % chez les mâles et de 63,9 % chez les femelles). La fréquence des cas (37,6 %) était significativement plus élevée ($p < 0,001$) chez les femelles gestantes que chez les non gestantes. Tous les foyers enregistrés se sont caractérisés par l'absence de rigidité cadavérique et de coagulation ainsi que par le décès de chamelles gestantes et allaitantes, mais aucun agent causal de type *Bacillus anthracis* n'a pu être isolé. En plus des pertes de lait dans le cas des chamelles allaitantes et de la perte des produits des chamelles gestantes affectées, la valeur moyenne des dromadaires trouvés morts a été estimée à 2 377,6 birrs éthiopiens (soit environ 264 dollars US). L'origine de cette mortalité est probablement multifactorielle. De ce fait, il est impératif d'étudier rapidement ce phénomène afin de savoir comment intervenir, en y consacrant des moyens financiers, techniques et humains suffisants pour que les causes du problème soient élucidées et la maladie maîtrisée.

Mots-clés

Cause multifactorielle – Dromadaire – Éthiopie – Groupe d'âge productif – Mort subite. ■

Misteriosa mortalidad de dromedarios (*Camelus dromedarius*) en Borana (Etiopía) y pruebas de su asociación a grupos de animales en edad reproductiva

F. Dawo

Resumen

En las zonas de pastoreo meridionales de Oromia (Etiopía) se observaron casos de muerte súbita de dromedarios que afectaban significativamente ($p < 0,001$) a machos y hembras de los grupos de edad productivos (se vieron afectados un 63,9% y un 10,8% de los dromedarios hembra y macho, respectivamente, de esos grupos de edad). Las hembras grávidas (37,6%) enfermaban con una frecuencia significativamente mayor ($p < 0,001$) que las no embarazadas. En el curso de distintos brotes se observó frecuentemente la ausencia de "rigor mortis" y de coagulación sanguínea, así como la muerte de hembras embarazadas o con crías lactantes, pero no se pudo aislar ningún agente etiológico del estilo de *Bacillus anthracis*. Sin contar la pérdida de leche (en el caso de las hembras con crías lactantes) y de las propias crías (en el caso de las hembras embarazadas), el valor de los dromedarios muertos asciende en promedio a 2377,6 birr (unos 264 dólares). Las hipótesis sobre las causas de mortalidad apuntan a una combinación de factores. Por ello urge investigar para descubrir el origen del problema y atajar la enfermedad definiendo una intervención adecuada, lo que exige más dedicación y una mayor aportación de recursos económicos.

Palabras clave

Causa multifactorial – Dromedario – Etiopía – Grupo de edad productivo – Muerte súbita.

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