

STUDY ON THE EPIDEMIOLOGY AND HISTOPATHOLOGY OF SARCOPTIC MANGE AND RINGWORM IN THE ONE-HUMPED CAMEL IN SOUTH OF MOROCCO

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ABSTRACT

A study was carried out between April and May 2009 at the slaughterhouses of three Southern Moroccan towns. It aimed at collecting epidemiological data on mange and ringworm in the one-humped camel, and taking skin samples from sick animals in order to study the histopathological patterns of these dermatosis in this species.

In total, 268 camels were examined, and skin samples were collected from 98 animals. On average 12% of all animals seen at the slaughterhouses, and 33% of animals with skin lesions suffered from mange. This disease was more frequent in older animals, without statistically significant differences between towns. Ringworm mean prevalence was 16% among all animals, 44% among animals with skin lesions. Most of the concerned camels were young.

The histopathological patterns of mange and ringworm in the one-humped camel are similar to that described in the other domestic species. During the study, different overall clinical pictures of a single affection were observed.

Key words: Histology, histopathology, mange, one-humped camel, ringworm, skin disease, Southern Morocco

In Morocco, promoting camel husbandry is a strategic issue for the economic development of Southern provinces. However, this promotion is limited by many zootechnical, health and socio-economic constraints. Particularly, skin diseases represent a major concern for South Moroccan camel farmers, and among them, sarcoptic mange which is the first most important camel disease in the country. This highly pruritic and contagious dermatosis, due to infestation with *Sarcoptes scabiei* var *cameli*, leads to dramatic declines in productivity, and sometimes to the death of affected animals if no treatment is undertaken (Khallaayoune *et al*, 2000; Kumar *et al*, 1992).

Besides mange, ringworm is also a very common skin disease in young individuals in bad health. In the one-humped camel, Trichophyton is the dermatophyte most implicated. (Maallem *et al*, 2002) Comparing to mange, it doesn't cause an important decrease in productivity, but some generalised clinical features affect the animal health state. Currently, medical or traditional treatments remain tedious, time consuming and relatively efficient.

The present study was carried out to collect epidemiological data on sarcoptic mange and ringworm in the context of breeding camel in Morocco, as well as skin samples, to determine the histopathological patterns of these two types of dermatosis in the one-humped camel.

Materials and Methods

Study zone

This survey was conducted at the slaughterhouses of three regions where camel farming is of high economical importance in Morocco: Guelmim, Tan-Tan and Laâyoune. In each of these towns, livestock is the main agricultural activity, based on drylands as the principal food resources for animals in extensive system. Camel population of each province is indicated in table 1.

Animals

During this trial, 268 camels were examined at the three slaughterhouses. During ante-mortem inspection, anamnesis forms reporting age, sex and breed, as well as a macroscopic description of skin lesions, were filled in.

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Table 1. Camel numbers and slaughter statistics in the three provinces.

Cities	Guelmim	Tan-Tan	Laâyoune
Camel numbers (heads)	6,000	11,000	72,947
Slaughtered camel numbers (heads)	2,849	1,203	2,616
Camel meat (kg)	323,559	117,604	265,426

(Sources : Monographs of the agricultural sector in the provinces of Guelmim in 2007, Tan-Tan and Laayoune in 2004)

Skin samples and histopathological sections

After camels slaughter and before skinning, biopsies were carried out. Each sample included a zone of injured skin and apparently healthy skin nearby. Furthermore, a second sample was taken in healthy skin in the same anatomic site as far as possible.

Full thickness skin sections were resected and fixed in formalin to be ready for paraffin embedding and routine histological test.

Statistical models

To assess mange and scabies prevalences differences according to age, sex and city, Chi-square test (5 or more than 5 individuals in each table cells), Chi-square test with Yates correction (some numbers comprised between 3 and 5) or Chi-square test with Montecarlo simulation (some numbers less than 3) were used. Different generalised linear models were tested with the freeware R, to assess the effects of age, sex and place, as well as the interactions between these variables.

Results

Mange and ringworm prevalence and variation factors

Prevalences of mange and ringworm in each town and on average are reported in table 2. The first underlined number indicates the relative prevalence to the total number of slaughtered animals during the study period. The second number indicates the relative prevalence to the number of slaughtered animals with skin lesions.

Mange was the first most important disease in Guelmim (46% of animals with skin lesions were affected by mange), while it was less common in Tan-Tan, where only 9% of individuals with skin lesions were affected (one camel out of 11). However, prevalence differences between towns weren't significant in our sample, the insufficient numbers decreasing the statistical power.

Table 2. Mange and ringworm prevalences in the different towns.

	Mange	Ringworm
Mean	10.3% ($\sigma=3.7$) 28.8% ($\sigma=18.6$)	23.2% ($\sigma=22.5$) 44.5% ($\sigma=32.9$)
Guelmim	12.5% 45.8%	2.3% 8.3%
Tan-Tan	6% 9%	47% 72.7%
Laâyoune	12.3% 31.7%	20.2% 52.4%

Ringworm represented more than 70% of diagnostic hypothesis in Tan-Tan, 20% in Laâyoune and 8% in Guelmim. According to the Chi-square test, these differences were significant ($p=0.005$). Nevertheless, these geographic variations may be due to the fact that the sex/age structure of our sample was not homogenous between towns (table 3). Consequently, we tried to assess the influence of sex and age in each town, as well as the existence of interactions between these factors.

Effect of age on the dermatosis prevalence

• Global sample

Ringworm was diagnosed in 70% of calves under one year, while this prevalence reached 32% among 1-3 years old camels and 11% among the over 3 years old. Mange was the most prevalent disease in older camel (over 3 years old); it was suspected in 32% among 1-3 years old camels with skin lesions, and in about 58% among camels over 3 years old. Among young under one year, mange prevalence remained high, reaching 21%.

Prevalence differences of mange between the three age groups were significant considering the whole sample, as well as the ringworm prevalence differences between camels under one year and the other age groups. However, these results were obtained taking data collected from the three cities together. In this effect, the effect of the age on mange and ringworm prevalence was assessed separately in the three towns.

• Local samples

In each of the three towns, the same trends as in the global samples were found. However, by testing separately the prevalence differences of mange and ringworm, among animals from the same town, between the different age groups, the following results were obtained:

Table 3. Numbers of camels affected by mange or ringworm in the different age/sex groups.

Cities	Nb of examined animals	Age (year)	Sex	No. of individuals with skin lesions	No. of mange cases	No. of ringworm cases
Guelmim	88	< 1	Male	1	0	0
			Female	1	0	1
		1-3	Male	10	6	0
			Female	5	0	1
		> 3	Male	6	4	0
			Female	1	1	0
Tan-Tan	17	< 1 an	Male	5	0	4
			Female	0	0	0
		1 - 3	Male	4	1	3
			Female	0	0	0
		>3	Male	2	0	1
			Female	0	0	0
Laâyoune	163	< 1	Male	36	9	23
			Female	7	0	7
		1-3	Male	10	4	3
			Female	1	1	0
		>3	Male	3	3	0
			Female	6	2	1

- Regarding sarcoptic mange: prevalence differences between the different age groups were not significant in none of the towns.
- Regarding ringworm: differences observed between the different age groups remained significant only in Laâyoune (p=0.005). In Tan-Tan and Guelmim, camel numbers were insufficient to conclude.

Effect of sex on dermatosis prevalence

Among 98 animals with skin lesions, the sex ratio (male/female) was 3.7 (78.6% males and 21.4% females).

Mange prevalence was 35.1% among males and 19% among females. Ringworm prevalence in both sexes was close, about 45%. Prevalence differences of mange and ringworm regarding sex weren't significant, in the global sample, as well as in the different towns. These results must be considered taking into account the small effective.

The different clinical features of mange and ringworm in the one-humped camel

• Mange

Many animals showed symptoms suggestive of mange, but macroscopic lesions, localisation and severity varied considerably. Three clinical pictures were distinguished:

- Chronic mange: it represented 71% of mange cases. Lesions were observed mainly on head and

neck and consisted in diffuse alopecia covered in scales, sparse and broken hairs, thickened and hyperpigmented skin.

- Beginning mange: it represented 13% of mange suspicions. Lesions were distributed over the head, the intern sides of limbs and axilla. In these regions, skin was completely hairless, crusting, seemed to be thickened (Figs 1 and 2). The skin texture was finely gritty.
- Mange in light-coloured skinned animals with a non pigmented iris ("zeroual" animals) represented 16% of mange suspicions. Lesions were distributed over the head, the axilla, the internal sides of hind limbs. The skin was hairless, oozing, and erythematous, thickened and wrinkled, with oedema in decline parts (Figs 3, 4 and 5).

In females affected by mange, only chronic clinical picture was found. In males over three years, mange cases were divided into 86% chronic mange and 14% beginning mange. In males aged one to three years, particular clinical picture of light coloured skinned animals and chronic mange represented 45.5% of mange cases, while the beginning mange represented 9%. In males under one year, chronic mange represented 78% of mange cases (Table 4). In our sample, prevalence differences of each mange feature, observed between males and females or between different age groups weren't significant.



Fig 1. Male calve <1-yr old, beginning mange ; Laâyounse slaughterhouse.



Fig 2. Male calve <1-yr old, beginning mange ; Laâyounse slaughterhouse.



Fig 3. Male camel, 1-3 yrs old; Laâyounse slaughterhouse.



Fig 4. Male camel, 1-3 yrs old; Guelmim slaughterhouse.

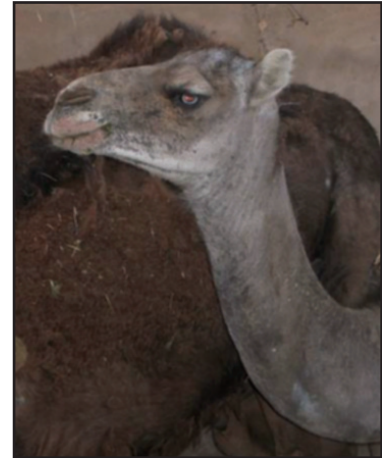


Fig 5. Male calve, 1-yr old; Guelmim slaughterhouse.

Table 4. Relative frequencies of different mange forms according to camel sex and age groups.

		Chronic mange	Beginning mange	Mange in light-coloured skinned animals
Males	Under 1 year	78% (n=7)	22% (n=2)	n=0
	1 - 3	45.5% (n=5)	9% (n=1)	45.5% (n=5)
	over 3 years	86% (n=6)	14% (n=1)	n=0
Females	Under 1 year	n=0	n=0	n=0
	1 - 3	100% (n=1)	n=0	n=0
	over 3 year	100% (n=3)	n=0	n=0

• **Ringworm**

Clinical overall pictures varied. Cases could be divided in several groups, according to the appearance of depilation lesions :

- “dry” form: lesions bottom is dry and covered in fine grey scales. This form represented 36% of ringworm suspicions.
- “crusting” form: lesions bottom is swollen, a floury scaling substance pokes out of it, and a thick crust strongly tied on to skin appears. 16% of individuals showed this form.
- “lumpy” form: crusts may widen, crack, inflame, epithelial fragments gather with blood and hairs to make up a thick crust easy to pull out, skin being ulcerated underneath. This form may be

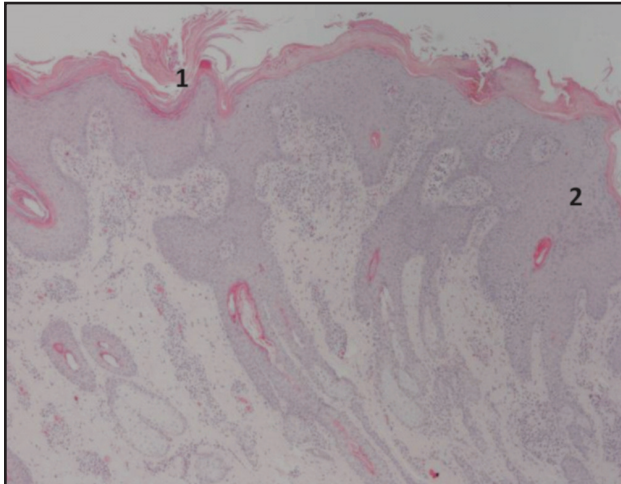


Fig 6. Superficial perivascular hyperplastic dermatitis with orthokeratotic hyperkeratosis (1), marked, irregular, widespread acanthosis (2), inflammatory infiltration of mononucleated cells. H&E stain, X 10 magnification.

Picture: Toulouse National Veterinary School, Department of Pathologic anatomy

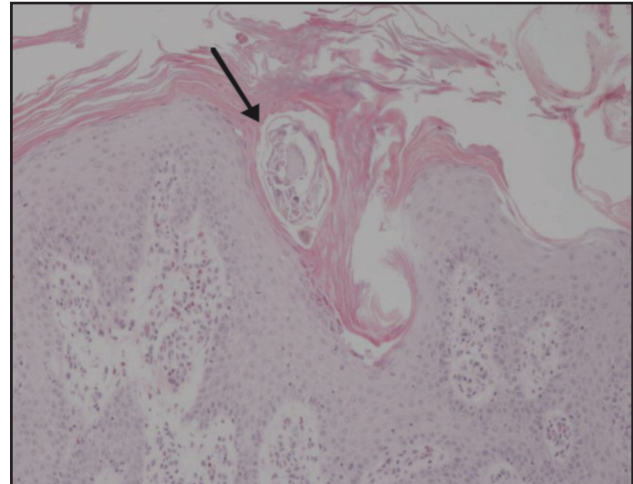


Fig 7. Sarcoptes in the *Stratum corneum* (black arrow). H&E stain, X 200 magnification.

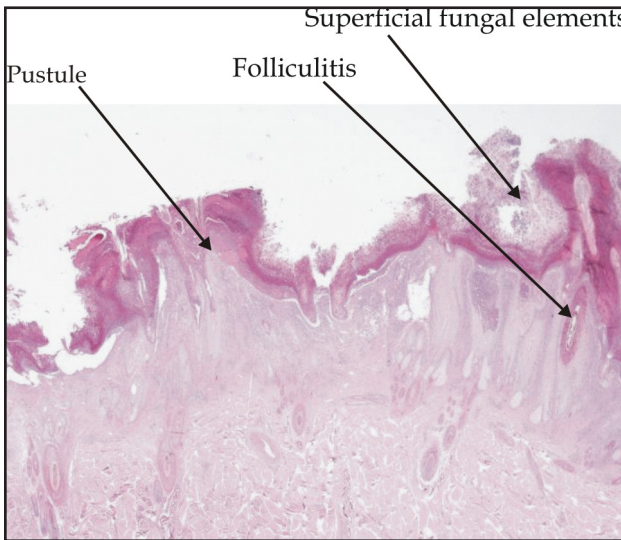


Fig 8. Intra-epidermal dermatitis and folliculitis. PAS Stain, X 40 magnification.

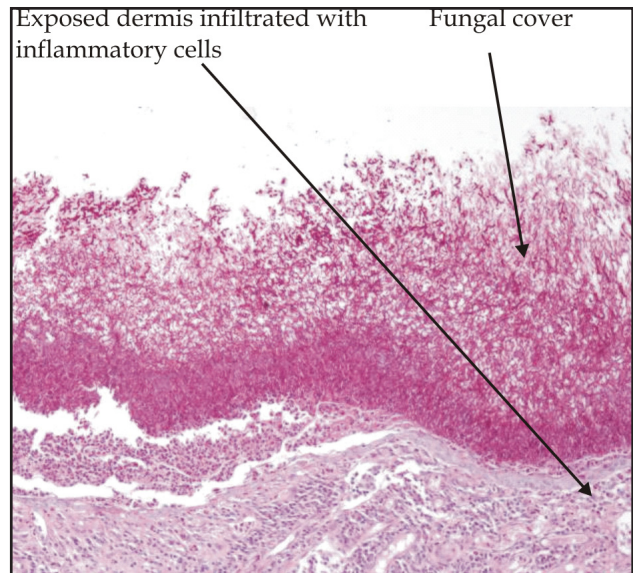


Fig 9. Closer view of Fig 8 severe fungal infestation. Epidermis was totally ruined, dermis is exposed. PAS stain, X200 magnification.

pruritic and turn to suppuration. This clinical picture affected 34% of animals.

- "extensive" form: lesions spread to the whole body, affected 14% of animals with ringworm.

The dry form represented most of the ringworm cases in males (41% of ringworm), followed by the lumpy form (32%). Crusting and extensive ringworms were the first most common forms in females.

In camels over 3 years old, only dry forms were diagnosed. In individuals aged 1-3 years old, the lumpy form was the first most frequent (43% of ringworm). In calves under one year, the dry

form was more frequently observed (34%), and the greatest number of extensive forms was found in this age group. However, prevalence differences of each ringworm form, according to individual sex or age weren't significant.

Extensive forms were more common in females under 1 year with 37.5% of ringworm. In under one year old males, the dry form ranked first, while the lumpy form constituted the essential of clinical pictures in males aged between 1 and 3 years old (Table 5).

Indeed, ringworm suspicions in Guelmim could be equally divided in dry and crusting form

(one animal in each case). In Tan-Tan the dry form represented 83% of ringworms, and the lumpy form 17%. In Laâyoune the lumpy form represented most of ringworm cases (41%) and extensive forms were observed, unlike in other towns. Dry form represented 22% of cases and the crusting form only 18%. Considering the whole sample, there was a statistically significant relationship between each ringworm forms and the culling place ($p=0.03$). However, these results have to be considered with caution, effectives are too small to set up precise statistical models, assessing the interactions between the different explanatory variables.

Table 5. Relative frequencies of different ringworm forms according to camel sex and age groups.

Sex	Age	Dry	Crusting	Lumpy	Extensive
Males	Under 1 year	41% (n=11)	18% (n=5)	30% (n=8)	11% (n=3)
	1 - 3	33% (n=2)	17% (n=1)	50% (n=3)	0%
	Over 3 years	100% (n=1)	0%	0%	0%
Females	Under 1 year	12.5% (n=1)	25% (n=2)	25% (n=2)	37.5% (n=3)
	1 - 3	0%	100% (n=1)	0%	0%
	Over 3 years	100% (n=1)	0%	0%	0%

Histopathological study

• Mange

The histopathological pattern of ringworm in the one-humped camel is similar to that exhibited in other animal species. It consists in a superficial perivascular hyperplastic dermatitis with hyperkeratosis and severe eosinophilic infiltrate (Figs 7 and 8). Sarcptes were rather rare on the histopathological samples. For example, only one Sarcptes was observed on a sample taken from the animal on Fig 4.

• Ringworm

In the dromedary, microscopic lesions are similar to that observed in other animal species: hyperplasia, hyperkeratosis, crusts, pustules, folliculitis and inflammatory infiltrate (Table 6)

The most frequent pattern observed in dry ringworm is a superficial perivascular hyperplastic dermatitis with hyperkeratosis. In the crusty form, pustules are added to the previous pattern. In lumpy ringworm, the pattern is the same as the one of the crusty form with folliculitis lesions. Finally, the

complete pattern was the most frequently found in extensive ringworm forms. Fig 9 and 10 illustrate microscopic lesions observed in an animal suffering from extensive ringworm.

Table 6. Relative frequencies of different histopathological patterns in the different ringworm clinical pictures.

	1	1 + 2	1 + 2 + 3	1 + 3	3	No evidence
Dry	36%	18%	27%			18%
Crusting		67%	16.5%		16.5%	
Lumpy	27%	36%	36%			
Extensive		16.5%	67%	16.5%		
Mean	21%	32%	35%	3%	3%	6%

- 1 : superficial perivascular or interstitial hyperplastic dermatitis with hyperkeratosis
 2 : intra-epidermal pustular dermatitis
 3 : folliculitis

Discussion

Sample structure

The sample age/sex structure differs from that of the overall camel population: 80% of camels with skin lesions were less than 3 years old; males under 3 years old represented the 2/3 of the sample. This may be explained by husbandry practices (young females are kept in the herd for renewal) and the consumer's preference for young animals meat. Consequently the results found during this study can't be directly extrapolated to the Moroccan camel population.

Dermatosis prevalences and variation factors

• Mange and ringworm

During this survey, mange mean prevalence rose to 12% among all examined animals, which was lower than what was found by Khallaayoune at Laâyoune slaughterhouse, during a study led between May 1994 and June 1995. The average prevalence reached 26.5%, with peak prevalence up to 42% (Khallaayoune *et al*, 2000). Prevalence of ringworm rose to 16% among all animals, which was lower than what was found in a study carried out from June 2002 to April 2003 in South Morocco, where 26% of camels were affected (El Jahouari *et al*, 2004).

• Variation factors

Mange prevalence was higher in older animals, and ringworm prevalence was higher in young calves under one year old. These results are in keeping with bibliography (Faye, 1997; Kumar *et al*, 1992). Mild and humid weather is favourable to fungal growth, and hence to ringworm development (Scott, 1988). In 2009, heavy rainfalls stroke Morocco Saharan provinces, especially near Dakhla. Numerous animals

which were slaughtered in Laâyoune came back from this place, where the shepherds had brought them to benefit from the high quality pastures.

For many years, ivermectin is freely distributed as grant from the Ministry of Agriculture and Fishery in Morocco, for breeders in Southern and disadvantaged regions, to control gastro-intestinal helminthosis which are responsible for huge economic losses in camels as well as in other species. This medicine had also an effect on ectoparasites like Sarcoptes, which may explain the lower prevalence of mange nowadays than in the past.

• *Interactions between different factors*

Interactions between all explanatory variables couldn't be assessed because of the low animals number. Mange appears to be more frequent in Guelmim; this dermatosis affects mostly older individuals which were in greater proportion in Guelmim than elsewhere. Besides, ringworm reached a high prevalence in Tan-Tan, but the high proportion of young animals slaughtered in this town must be taken into account.

The different clinical overall pictures of mange and ringworm

• *Mange*

The different overall clinical pictures may be related to different stages of disease progression. Beginning mange lesions were only located in thin skin zones, where symptoms usually appear first (head, intern side of limbs, axilla), without spread to the rest of the body. The fine crusts and the skin gritty texture may be due to the burst of vesicles present where mite begins to burrow into the epidermis.

The light-coloured skinned animals exhibited lesions over the same zones as previous animals. However, in this case, skin was erythematous and there was oedema in decline parts of the body. These two lesions were typical of mange initial acute phase.

In the chronic form, lesions were mostly located on the neck, limbs and buttock, so in zones frequently in contact with other camels and easy to scratch. This explains the widespread alopecia and the skin thickening in reaction to constant itching.

• *Ringworm*

Different overall clinical pictures are related to different stages of disease progression. This change depends on the balance between the host and the parasite. This balance depends on climate which is more or less favourable to fungal development, on

treatments undertaken by the breeder and fungus. In a survey conducted between 2002 and 2003 in South of Morocco, the kind of only identified species from ringworm lesions in camels was *Trichophyton sarkisovii* (El Jouhari *et al*, 2004). The year 2009 faced a mild and humid climate, leading to a greater fungal growth and explaining partially, the development of extensive forms. On the other hand, the host parasite interaction depends on animal capacity to build an efficient immunity response. Focusing on that point, age, feeding, treating infections likely to influence the host defense mechanisms (vermifugation, vaccination against camelpox), mineral deficiencies, in zinc, copper, A and C vitamins may be considered. It would be thus interesting to assess the correlation between mineral deficiencies and observed ringworm form.

Histopathological patterns of mange and ringworm in the one humped camel

According to previous works dealing with this issue, the histological structure of the dromedary skin was similar to that of other species (Abi, 1987; Khabous, 1987; Pfeiffer *et al*, 2005). Observations carried out during this study showed that microscopic lesions in camels suffering from mange or ringworm were the same as that described in other animal species.

Conclusion

Sarcoptic mange and ringworm were found to be highly frequent skin diseases in the one-humped camel in South of Morocco. The microscopic analysis of the skin lesions revealed that the histopathological patterns of these dermatosis were similar to that described in other animal species.

Several factors have an effect on skin diseases outbreaks such as genetics, nutritional status, and breeding practices in addition to age and climate. The interaction with mineral status (especially zinc and copper which play a known role on integument integrity) is under study. Further analysis (local skin immunity, zinc concentration in the skin) are expected for better understanding of the particular sensitivity of camel to skin diseases.

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