

## Bovine Hypodermosis in North-Central Algeria: Prevalence, Intensity of Infection and Risk Factors

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### Abstract

From January to June 2009 the biggest livestock market and five bovine farms of Bejaia department (Northcentral Algeria) were visited in order to undertake an epidemiological survey on warble fly infestation (WFI). A total of 3.442 and 226 bovines were clinically examined in both market and farms, respectively. The prevalence was higher in farms (18.1%) than in the animal market (3.7%). On the contrary, the intensity of infection was highest in the market ( $12.61 \pm 7.78$  vs  $7.5 \pm 4.15$ ). The husbandry system exerts a significant effect on the prevalence of WFI, being the prevalence highest under extensive management. However, cattle age, sex and breed did not exert a significant effect on WFI prevalence. Breed was the only factor influencing the intensity of infection; the Montbeliarde breed was the most heavily infested as compared to the crossbreed and the local breed.

**Keywords:** Bovine hypodermosis, Prevalence, Intensity, Risk factors, North-central Algeria

## Kuzey-Orta Cezayir'de Sığır Hypodermosis: Yaygınlık, Enfeksiyon Yoğunluğu ve Risk Faktörleri

### Özet

Büvelek sineği enfestasyonu (WFI) üzerine bir epidemiyolojik araştırma gerçekleştirmek üzere Ocak-Haziran 2009 döneminde Bejaia Bölgesi'nin (Kuzey-Orta Cezayir) en büyük hayvan pazarı ve beş sığır çiftliği ziyaret edildi. Pazar ve marketlerde sırası ile toplam 3.442 ve 226 sığır klinik olarak muayene edildi. Prevalansın çiftliklerde (%18.1) hayvan pazarına göre (%3.7) daha yüksek olduğu belirlendi. Fakat, enfeksiyonun şiddetinin pazarda ( $12.61 \pm 7.78$  vs  $7.5 \pm 4.15$ ) en yüksek olarak gözlemlendi. Ekstansif yetiştiricilikte en yüksek yaygınlıkta olan WFI prevalansı üzerine yetiştirme sistemi önemli bir etki göstermektedir. Ancak, sığır yaş, cinsiyet ve ırk özelliklerinin WFI yaygınlığı üzerinde önemli bir etki göstermediği belirlendi. Enfeksiyon yoğunluğunu etkileyen tek faktör olarak ırk özelliği bulundu; melez ve yerli ırk ile karşılaştırıldığında Montbeliarde ırkının en ağır enfestasyona maruz kaldığı gözlemlendi.

**Anahtar sözcükler:** Sığır hypodermosis, Prevalans, Yoğunluk, Risk faktörleri, Kuzey-orta Cezayir

### INTRODUCTION

Cattle hypodermosis is a myiasis caused by larvae of *Hypoderma bovis* and *Hypoderma lineatum* (Diptera: Oestridae) and characterized by the presence of warbles under the skin of infested animals. Hypodermosis may also infect humans accidentally <sup>[1]</sup>.

Bovine hypodermosis is still widely distributed all over the Northern hemisphere <sup>[2]</sup> where has been noticed in

more than 50 countries from North America, Europe, Africa and Asia; nevertheless, warble fly infestation (WFI) has been occasionally found in the south of Equator, Argentina, Chile and in South of Africa as a consequence of cattle importation <sup>[3]</sup>.

These parasites have an annual synchronized biological cycle, from summer to the following spring. The first endo-



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parasitic stage migrates through the deep connective tissues of their hosts. In spring, larvae reach the dorsal subcutaneous tissue and molt into the second and third larval stages, producing swellings on the skin along the back called warbles. Mature third larval stages fall on the ground and pupate at the end of spring; one month later the adult stages emerge. These flies are unable to feed and consequently, have a short life of one week; they spread the disease by laying their eggs on the hair of the cattle. *Hypoderma* spp. cause economic losses by reducing milk production (10-15%) and affecting weight gain (20%), welfare, bovine immune defense mechanisms and the leather industry (more than 10 warbles represent 50% devaluation of hides)<sup>[4]</sup>.

In Algeria little data exist about WFI<sup>[5]</sup>. In the North East of the country several aspects of this disease had been explored in the 90s by Benakhla *et al.*<sup>[6,7]</sup>, but the knowledge must be updated. Unfortunately, in Algeria, like in so many countries where warble flies are present, cattle breeders are confronting with severe economic losses in the absence of a warble management program.

The present study was carried out to determine the prevalence of WFI, its intensity and the risk factors involved in the incidence of this myiasis in northcentral Algeria.

## MATERIAL and METHODS

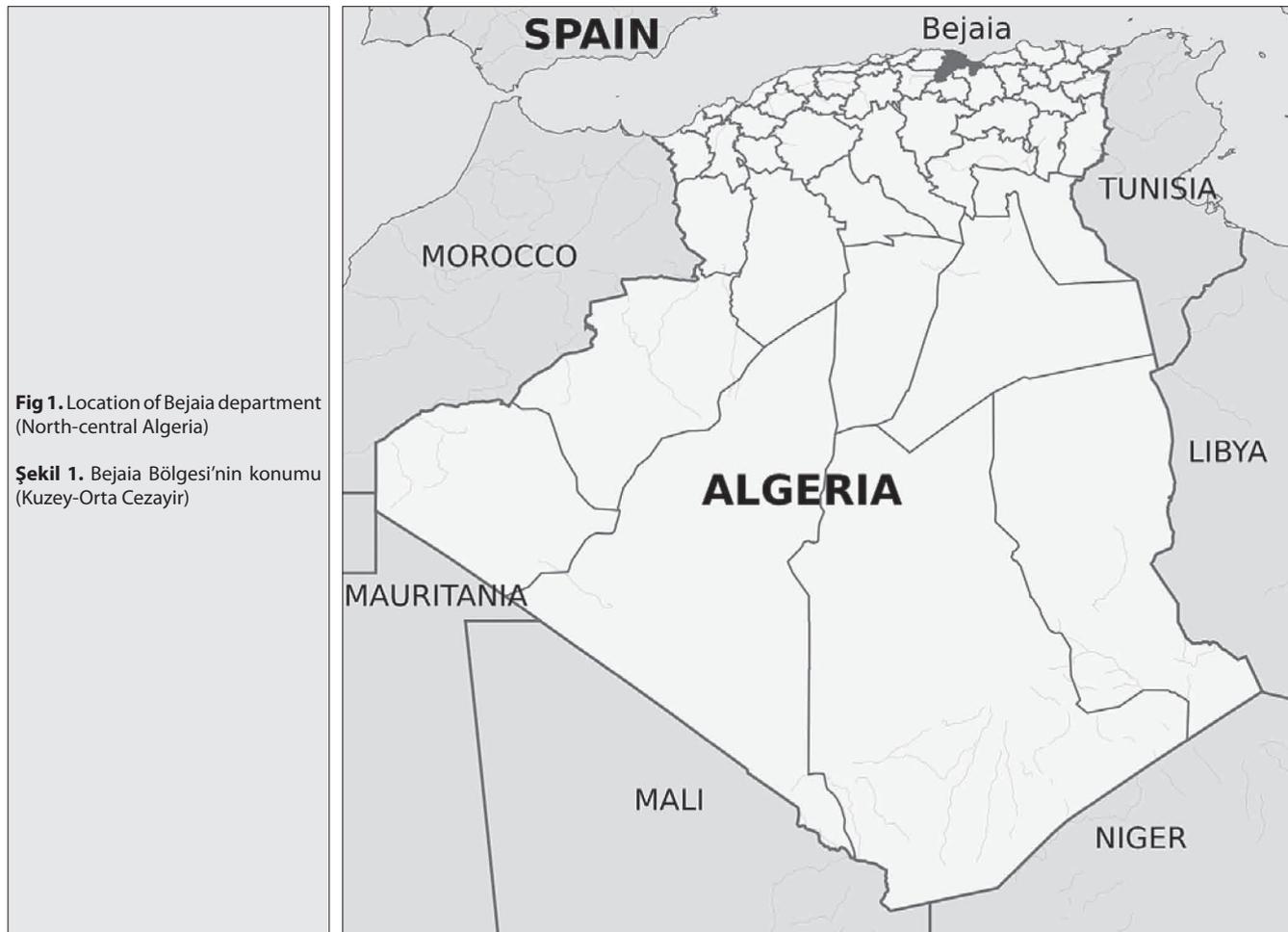
### Study Area

The study was conducted in the department of Bejaia (Fig. 1), located in North-central Algeria (36°45'N5°04'E). This department belongs to the Tellian Atlas and has a superficies of about 3223.48 km<sup>2</sup>. Climate is Mediterranean one with hot/dry summers and wet/fresh winters.

### Animals

In order to determine the prevalence and the intensity of WFI, the biggest livestock market of Bejaia, located in Sidi aich city, was fortnightly visited, from January to June 2009. This market receives bovines from different departments from northern Algeria. A total of 3.442 animals were examined visually and by palpation of the dorsal area to register the presence and the number of warbles.

In addition, to establish the risk factors involved in the occurrence of bovine hypodermosis, five cattle farms with different husbandry systems (intensive, semi-extensive or extensive) were monthly visited during the same period of time, with a total of 226 animals examined (32 males and 194 females). Sex, breed, age and husbandry system were



taken into account as risk factors. Three categories of age were considered: animals younger than two years ( $n=51$ ), between two and five years ( $n=93$ ) and bovines older than five years ( $n=82$ ). Four breeds were taken into account in our study: local breed ( $n=97$ ), Prim Holstein breed ( $n=14$ ), Montbeliarde breed ( $n=39$ ) and Crossbreed ( $n=76$ ).

Naturally emerged larvae ( $n=29$ ) were collected and preserved in ethanol 70° and subsequently identified by using the morphological keys as described by James [8] and Zumpt [9].

### Statistical Analysis

Three parametric statistical tests were used in the studying the risk factors involved in WFI. Pearson's Chi-squared test was used to study the effect of husbandry system, age, breed and sex on the prevalence. Fisher's exact test (2-sided) was exploited for the same goal as precedent. Chi-squared automatic interaction detector (CHAID) was used after chi-squared test to classify results in homogeneous groups. For the examination analysis of the intensity of infection, a unifactorial association analysis (ANOVA) was applied on the 42 positive animals detected in the farms sampled.

Statistical analyses were done using R statistical package (R v.2.15.2; 2012-10-26). CHAID algorithm was performed with Answer Tree 3.1 (SPSS Inc., Chicago, IL USA) [10].

## RESULTS

### Prevalence and Intensity of Infestation

Table 1 represents the monthly evolution of the prevalence by *Hypoderma* spp. recorded in the animal market. The inspection of the animals and the warble counting enabled us to note that on 3,442 inspected animals 129 were found to be warbled, which represented an overall prevalence of 3.7%. In the present study, the prevalence in the animal market increased progressively until April (7.1%); after this month the number of infested animals began to descend until June. No animal was found infested after the first week of June. The mean intensity of infestation in the animal market was  $12.6 \pm 7.78$ ; the highest intensity ( $13.1 \pm 7.35$ ) was recorded in March.

### Analysis of Risk Factors

Table 2 shows the prevalence and intensity of infestation in the five studied farms, along with the management system in each of them. The overall prevalence in the farms was 18.1%, with an intensity of infestation of  $7.5 \pm 4.15$ . The prevalence is higher on cattle under extensive and semi-extensive husbandry systems. Pearson's Chi-squared test revealed a significant effect of management system on the WFI ( $\chi^2= 19.555$ ; Fisher's exact test  $P < 0.001$ ). The CHAID algorithm divided population studied in three groups,

**Table 1.** Monthly evolution of the prevalence and the intensity of infestation in Bejaia livestock market (Northcentral Algeria)

**Table 1.** Aylık yaygınlık gelişimi ve Bejaia hayvan pazarında enfestasyon yoğunluğu (Kuzey-Orta Cezayir)

Month	Number of Examined Animals	Number of Infested Animals	Prevalence (%)	Total Number of Warbles	Intensity of Infestation
January	150	4	2.7	35	$8.7 \pm 3.09$
February	507	10	2.0	49	$4.9 \pm 2.51$
March	791	46	5.9	604	$13.1 \pm 6.20$
April	678	48	7.1	306	$6.4 \pm 3.24$
May	674	18	2.7	84	$4.7 \pm 2.47$
June	642	3	0.5	4	$1.3 \pm 0.58$
TOTAL	3442	129	3.7	1082	$12.6 \pm 7.78$

**Table 2.** Prevalence and intensity of infestation in the farms according to the management system

**Table 2.** Çiftliklerde yönetim sistemine göre yaygınlık ve enfestasyon yoğunluğu

Farm	Management System	Number of Examined Animals	Prevalence	Intensity of Infection
Farm 1	Semi-extensive	162	21 (12.9%)	$5 \pm 2.28$
Farm 2	Semi-extensive	15	7 (46.6%)	$13 \pm 3.21$
Farm 3	Intensive	19	0 (0%)	0
Farm 4	Extensive	16	9 (56.2%)	$6.6 \pm 2.82$
Farm 5	Semi-extensive	14	5 (35.7%)	$12 \pm 3.03$
TOTAL		226	18.1	$7.5 \pm 4.1$

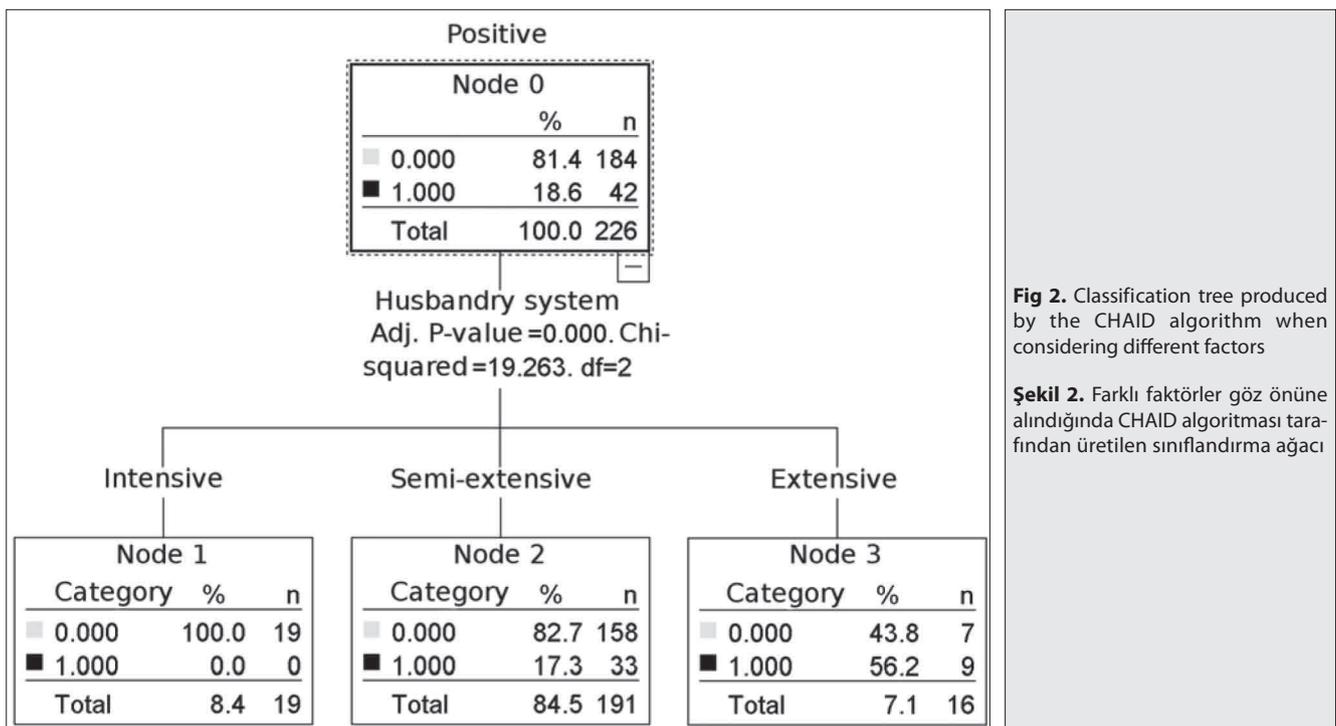


Fig 2. Classification tree produced by the CHAID algorithm when considering different factors

Şekil 2. Farklı faktörler göz önüne alındığında CHAID algoritması tarafından üretilen sınıflandırma ağacı

intensive, semiextensive and extensive management, in ascending prevalence order (Fig. 2). No significant association between WFI prevalence and age, breed or sex was detected.

Likewise, one analysis of variance (ANOVAs) did not detect significant effect of the sex of the animals or management system on the intensity of infestation. However, the precedent parametric test showed a very significant association between breed and intensity of infestation (F=10.96; P=0.002). With Tukey multiple comparisons of means, the Montbeliarde breed was detected as the most heavily infested or the most sensitive to WFI. Besides, the effect of farm on intensity of infestation was very significant (F=20.97; P<0.001). The Tukey test shows two homogeneous groups (farms 1 and 4, and farms 2 and 5). Curiously, there was no effect of age on the parasitic burden.

Out of the 29 identified larvae, 16 (55%) was found to belong to *H. lineatum* and 13 (45%) to *H. bovis*.

## DISCUSSION

The results of the present study provide initial baseline data on epidemiological assessment of the disease in northern Algeria, which is necessary before the implementation of any control and eradication program.

No animal was found infested after the beginning of June. This result did not fully agree with those of a previous survey done in an Algerian slaughterhouse [5], in which nodules were found from beginning of October until the

end of April. Those differences could be explained by the change in weather conditions from one year to another. Indeed, *Hypoderma* sp. biology, as occurs with most of insects, is noticeably conditioned by weather conditions; climate directly influences the development of free stages of the parasite, affecting the chronology of this myiasis, specially the time of appearance of warbles in the back, emergence of the prepupal grubs, pupation on the ground and adult emergence, and the intensity of infestation [11].

The higher prevalence in farms versus animal market could be due to the fact that the major part of bovines came from different departments from northern Algeria where the climate and the management system are different.

The rates of infestation found in our study were lower than those recorded by Benakhla et al. [7] in the Northeast of Algeria, and in our opinion, this fact could be mainly explained by the widely use of avermectins in Bejaia department by cattle breeders. It has been demonstrated simultaneously, in North America [12] and in France [13], that ivermectin was highly effective even, at very low dosages (0.2 mg/per kg weight) against the endo-parasitic stages of *Hypoderma* spp. In addition, it is usual to notice a wide variation in the prevalence of WFI among different parts of the world and even within the same country [14]. This variation in the rate of prevalence of WFI in different areas might be due to the differences in the environmental conditions (topography of the land, season, humidity, temperature, rain fall, wind velocity) affecting the development of the warble flies [15].

In our survey, *H. bovis* (45%) and *H. lineatum* (55%)

were found infesting cattle, although there was a slight predominance of *H. lineatum*. This statement agrees with previous investigations [5]. It is crucial to identify the distribution of the two species, firstly because *H. bovis* is currently believed to affect only cattle living in the Northern countries, and secondly because the impact of *H. bovis* on animal welfare and health is more important than *H. lineatum* due to the fact that if treatments are not carried out promptly, when first stage larvae are still in the peri-rachidian channel, paralysis of the hind quarters may occur. This finding is of relevance for the correct use of drugs against hypodermosis [1].

The management system was found to exert an effect on the prevalence of bovine hypodermosis, since cattle at pasture have more chances to contact with warble flies than those kept in stables. This result agrees with several previous studies [11,16]. Ahmed *et al.* [17] observed that the major risk factor for hypodermosis positivity is the free grazing practices.

Differences in parasitic burden among breeds showed a very consistent pattern in the present study, the Montbeliarde breed seemed to be the most heavily infested. This would suggest that there was apparent breed preference on the part of the ovipositing flies. Certain breeds have been shown to harbor greater numbers of grubs [6,18]. According to Charbon and Pfister [19] the differences are a result of differences in skin thickness which affect larval survival. However, Panadero *et al.* [11] considered that the difference between breeds is mainly caused by differences in the husbandry system. In our case, this difference might be due to the fact that the Montbeliarde is a dairy breed and dairy cows in Algeria spend long time in pasture. It is well known that daily duration of pasturage affect directly the parasitic burden.

Curiously, no significant difference among age has been found. However, it is important to point out that a certain degree of resistance against the infestations by *Hypoderma* is acquired after repeated exposures of the animal to the parasite [20-22]. Therefore, if an old animal had been never exposed to the parasite, it would have the same sensibility as a younger one. Indeed, some authors such as Ahmed *et al.* [23] found no differences in the intensity of infestation with respect to different factors studied including age, breed, etc, except for previous exposure to the parasite, so animals that had presented warbles in previous years showed less warbles than those no previously infested. It is concluded that management system is the most important factor affecting the prevalence of bovine hypodermosis.

There was no significant difference of intensities respect to the sex of the animals. Other authors found that the males were more heavily infested than females [14,24] because most males are kept tied at the stables, so they are less exposed to the parasite than females.

Finally, the possibility of an underestimated prevalence of WFI mostly in the animal market cannot be ruled out as it was based on direct examination. Further studies by using more sensitive techniques like ELISA [22] are needed for an early diagnose of bovine hypodermosis before the larvae reach the back and subsequently to avoid economic losses by implementing an early efficient treatment against warble fly infestation.

### CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

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