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Research paper

Risk factor meta-analysis and Bayesian estimation of genetic parameters and breeding values for hypersensibility to cutaneous habronematidosis in donkeys

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ABSTRACT

Cutaneous habronematidosis (CH) is a highly prevalent seasonally recurrent skin disease that affects donkeys as a result from the action of spirurid stomach worm larvae. Carrier flies mistakenly deposit these larvae on previous skin lesions or on the moisture of natural orifices, causing distress and inflicting relapsing wounds to the animals. First, we carried out a meta-analysis of the predisposing factors that could condition the development of CH in Andalusian donkeys. Second, basing on the empirical existence of an inter and intrafamilial variation previously addressed by owners, we isolated the genetic background behind the hypersensibility to this parasitological disease. To this aim, we designed a Bayesian linear model (BLM) to estimate the breeding values and genetic parameters for the hypersensibility to CH as a way to infer the potential selection suitability of this trait, seeking the improvement of donkey conservation programs. We studied the historical record of the cases of CH of 765 donkeys from 1984 to 2017. Fixed effects included birth year, birth season, sex, farm/owner, and husbandry system. Age was included as a linear and quadratic covariate. Although the effects of birth season and birth year were statistically non-significant ($P > 0.05$), their respective interactions with sex and farm/owner were statistically significant ($P < 0.01$), what translated into an increase of 40.5% in the specificity and of 0.6% of the sensibility of the model designed, when such interactions were included. Our BLM reported highly accurate genetic parameters as suggested by the low error of around 0.005, and the 95% credible interval for the heritability of ± 0.0012. The CH hypersensibility heritability was 0.0346. The value of 0.1232 for additive genetic variance addresses a relatively low genetic variation in the Andalusian donkey breed. Our results suggest that farms managed under extensive husbandry conditions are the most protective ones against developing CH. Furthermore, these results provide evidence of the lack of repercussion of other factors such as age or sex. Potentially considering CH hypersensibility as a negative selection aimed goal in donkey breeding programs, may turn into a measure to improve animal welfare indirectly. However, the low heritability value makes it compulsory to control environmental factors to ensure the effectiveness of the breeding measures implemented to obtain individuals that may genetically be less prone to develop the condition.

1. Introduction

Cutaneous habronematidosis (CH) is an Equidae specific skin disease that occurs when stomach worm larvae from the spirurid species comprising the superfamily Habronematidae (*Habronema* or *Draschia*, for instance) are deposited on injured or irritated skin tissue or mucous membranes (Giangaspero and Traversa, 2017). Although donkey cutaneous habronematidosis (summer sores) would not be scientifically

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described until a few decades ago (Mohamed et al., 1989), current research suggests this dermatological condition causes more severe lesions in donkeys than it does in other equids such as horses and their hybrids (White, 2013). Traditional nomenclature ("Summer or Jack sores") not only highlights a higher disease incidence and severity reported in donkeys (White, 2013), but also the progressively increasing incidence of this disease when weather conditions become warmer in late spring or early summer (late April through June, generally after March rainy periods), partially regressing or even disappearing in winter (Gerry, 2007).

A higher predisposition to develop cutaneous habronematidosis has been suggested for grey or diluted coat equines (Pusterla et al., 2003; Caro et al., 2014), such as the Andalusian donkey. However, neither breed, sex nor age different predilections seems to exist in horses (Reed et al., 2009), and no statistically proven information has been reported for donkeys up to the date. Moist body orifices and areas (eyes, lip commissures, ears, ventral abdomen, prepuce, penis and urethral process) are more commonly affected as they are more likely to attract the attention of parasite carriers such as flies. Areas on the limbs, especially from the fetlock to the coronary band, are frequently prone to mild cuts, scrapes, and trauma and thus can also be susceptible to summer sores. In addition, biting flies prefer to alight on shaded parts of animals lower on their bodies (Mohamed et al., 1989; Schuster et al., 2010; Pugh et al., 2014). The results can range from annoying and unsightly to fatal. Young foals, thin-skinned and poor body condition animals are especially hypersensible to the action of carrier flies (Giangaspero and Traversa, 2017). In the particular case of donkeys, these parts are so thin that are easily harmed by the larvae, which cause discomfort and distress as they progress in their life cycle, what becomes a critical point for the welfare of the species.

Although equids are the final host of the parasites responsible for this condition, the cutaneous myiasis caused by the larvae of these gastrointestinal parasites occurs because of an abnormal step in the normal life cycle of the parasites (Fig. 1). These misplaced larvae cannot grow into their adult forms in such locations, but still induce a severe local inflammatory reaction characterized by intense swelling, ulceration, redness, and itching. Donkeys produce self-inflicted injuries during the subsequent rubbing and scratching to alleviate the itching produced by the simultaneous action of carrier or vector parasites, such as flies, and the action of the larvae, what apart from irritating the animals, damages the skin and makes it easier for the larvae to access the stomach through the mouth (Pugh et al., 2014).

The selection of other species against their enhanced hypersensibility to gastrointestinal parasites has been suggested as an alternative to develop the sustainable control of parasite infections (Gutiérrez-Gil et al., 2010; Kornaś et al., 2015). Apparently, some equids tend to be more predisposed to suffer from cutaneous habronematidosis than others, exhibiting clinical signs on consecutive years, whereas other individuals on the same premises never develop this condition (Pugh et al., 2014). Despite CH is a highly prevalent condition, with 94.5% of the Andalusian donkeys affected at least once in their lives, there is a simultaneous inexistence of studies testing for the conditioning factors that may be involved or the genetic background existing behind cutaneous habronematidosis hypersensibility in donkeys. The present model not only computes the strength of the effects of highly predisposing factors on the appearance of this skin condition, which may enable enhancing the implementation of prophylactic measures, but also isolates the additive genetic component laying underneath CH hypersensibility. This way, we approach the hypothetical possibility of the implementation of a selective breeding plan for the individuals, which may indirectly reduce the incidence of cutaneous habronematidosis. Breeding for less CH sensitive donkeys together with the implementation of proper husbandry techniques may translate into the avoidance of detrimental repercussions for donkey welfare derived from the development of this disease.

Basing on the empirical observation of a potential different intra and interfamilial affectation among the individuals, the first aim of this study was the isolation and study of the strength of potential

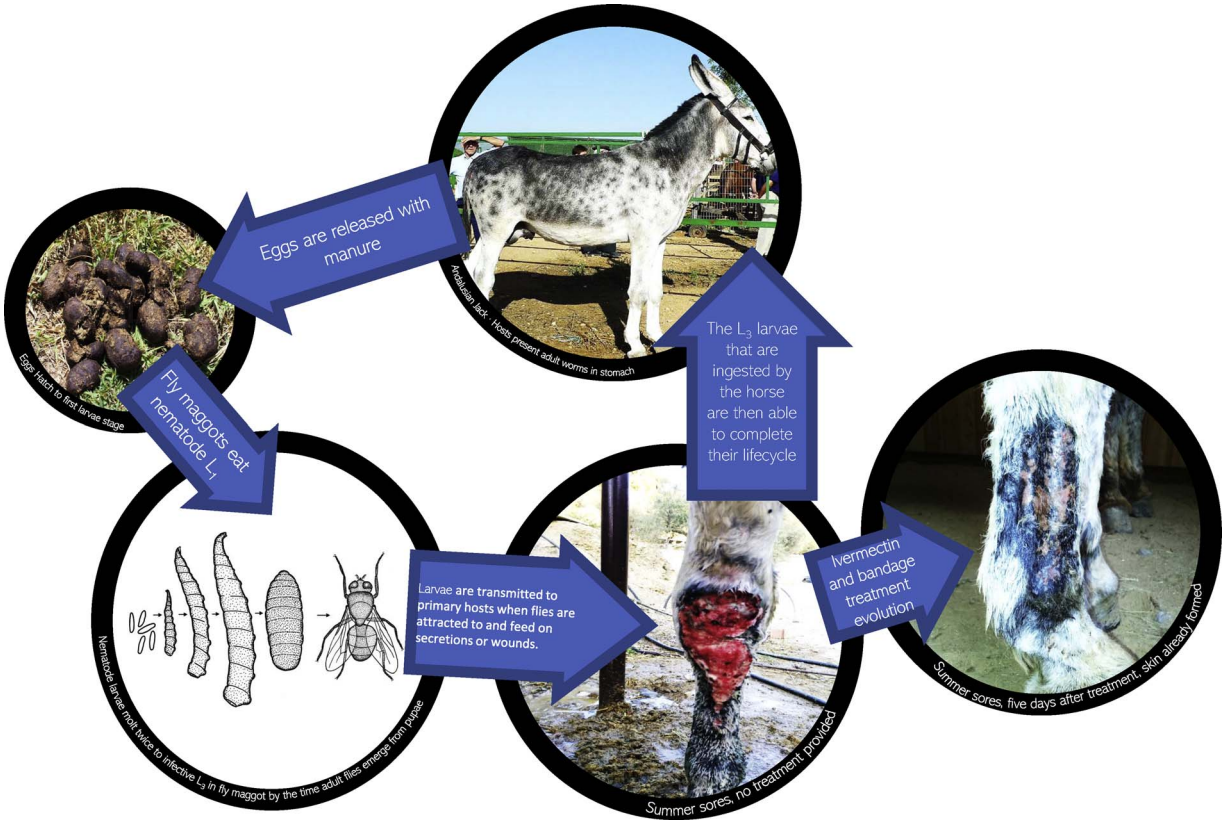

Fig. 1. Cutaneous habronematidosis cycle in donkeys.