DOI: 10.5433/1679-0359.2012v33n3p1113

# Clinical and histopathological aspects of the insect bite hypersensitivity in horses

# Aspectos clínicos e histopatológicos da hipersensibilidade à picada de insetos em equinos

Jose Paes Oliveira-Filho[1]; Viciany Erique Fabris[2]; Roberto Calderon Gonçalves[3]; Rogério Martins Amorim[3]; Simone Biagio Chiacchio[3]; Alexandre Secorun Borges[3*]

## Abstract

In this study, the clinical and histopathological aspects of insect bite hypersensitivity (IBH) were assessed in horses. For this purpose, 12 horses with histopathologically confirmed cases of IBH of the skin were selected. The 12 animals were from 10 stud farms located in different municipalities of the state of São Paulo, Brazil. The main clinical findings included severe pruritus, alopecia and signs of irritability. The lesions were diffuse and predominantly dorsal, with the mane, tail and face most commonly affected. Histologically, perivascular lympho-histiocytic and eosinophilic dermatitis were also evident. Other findings included orthokeratotic hyperkeratosis, acanthosis and spongiosis. Thus, it was concluded that IBH could be diagnosed in horses through the combined use of clinical and epidemiological data and histopathological findings.
**Key words:** Dermatopathology, allergic dermatitis, *Culicoides*, pruritus, horses

## Resumo

Foram avaliados os aspectos clínicos e histopatológicos da hipersensibilidade à picada de insetos (HSPI) em equinos. Para isso, foram selecionados 12 cavalos em que a suspeita clínica de HSPI foi confirmada através do exame histopatológico da pele. Os 12 animais eram provenientes de dez haras localizados em diferentes municípios do estado de São Paulo. Os principais achados clínicos incluíam prurido intenso, alopecia e sinais de irritabilidade. As lesões eram difusas e predominantemente dorsais sendo a crina, a cauda e a face geralmente acometidas. Histologicamente evidenciou-se dermatite perivascular linfo-histiocítica e eosinofílica. Outros achados incluíam hiperceratose ortoceratótica, acantose e espongiose. Pode-se concluir que o diagnóstico de HSPI em equinos pode ser realizado através da associação dos dados clínico-epidemiológicos com os achados histopatológicos.
**Palavras-chave:** Dermatopatologia, dermatite alérgica, culicoides, prurido, equinos

[1] Pós-Doutorando do Deptº de Clínica Veterinária da Faculdade de Medicina Veterinária e Zootecnia, Universidade Estadual Paulista, UNESP, Botucatu, SP. E-mail: zefilho@fmvz.unesp.br
[2] Profª. do Deptº de Patologia da Faculdade de Medicina de Botucatu, UNESP, Botucatu, SP. E-mail: vfabris@fmb.unesp.br
[3] Profs. do Deptº de Clínica Veterinária da Faculdade de Medicina Veterinária e Zootecnia, UNESP, Botucatu, SP. E-mail: calderon@fmvz.unesp.br; rmamorim@fmvz.unesp.br; chiacchios@fmvz.unesp.br; asborges@fmvz.unesp.br
[*] Author for corespondence

Recebido para publicação 25/10/11 Aprovado em 27/03/12

## Introduction

Insect bite hypersensitivity (IBH) in horses is a seasonally recurring chronic disease characterized by superficial dermatitis, which is commonly located in the mane, tail and withers (BROSTRÖM; LARSSON; TROEDSSON, 1987). Also known as summer eczema, summer seasonal recurrent dermatitis, allergic dermatitis resulting from insect bites or *Culicoides* hypersensitivity (KLEIDER; LEES, 1984; PORTUGAL et al., 1996; SCHILD; FERREIRA; SOARES, 2003; HALLAMAA, 2009), IBH is the most significant allergic disease (KNOTTENBELT, 2009) and the most common cause of pruritus in horses (YU, 2006). Pruritus occurs as the direct result of the insect bite (YU, 2006) and the hypersensitivity reaction, which is mediated mainly by IgE (FREY; BERGVALL; EGENVALL, 2008; WAGNER; CHILDS; ERB, 2008; WAGNER et al., 2009), to substrates from the saliva of insects from the genera *Culicoides* and *Simulium* (HELLBERG et al., 2009; SCHAFFARTZIK et al., 2009; WAGNER et al., 2009). A similar disease has also been described in cattle, goats and sheep (YERUHAM; BRAVERMAN; ORGAD, 1993; SOUZA et al., 2005; CORRÊA et al., 2007; BARBOSA et al., 2011).

IBH has a worldwide distribution (McCAIG, 1973; BROSTRÖM; LARSSON; TROEDSSON, 1987; SCOTT; MILLER, 2003; BJÖRNSDÓTTIR et al., 2006; HALLAMAA, 2009) without showing a predilection for gender, coat color or age (SCOTT; MILLER, 2003; HALLAMAA, 2009). In Brazil, *Culicoides* biting midges and black flies have been found parasitizing horses (CALVÃO-BRITO et al., 1998), and insects belonging to the *Culicoides* genus have been shown to be responsible for this disease in sheep (SOUZA et al., 2005; CORRÊA et al., 2007; BARBOSA et al., 2011) and horses (PORTUGAL et al., 1996; SCHILD; FERREIRA; SOARES, 2003). Other insects, such as *Haematobia irritans* and *Stomoxys calcitrans,* have also been implicated in the etiology of this disease in horses (PERRIS, 1995; SCOTT; MILLER, 2003; YU, 2006).

In general, a higher incidence of IBH is observed during the warmer months of the year (McGAIG, 1973; HALLAMAA, 2009), as this time period coincides with the increased presence of insects (ANDERSON; BELTON; KLEIDER, 1988; GREINER, 1995). In countries with a hot, tropical or subtropical climate, disease may occur throughout the year, although an elevated incidence of disease is typically observed during the hottest months (SCOTT; MILLER, 2003). IBH disease is clinically characterized by severe pruritus, alopecia and consequent excoriation, which result in the formation of erosive lesions and secondary bacterial infections (BROSTRÖM; LARSSON; TROEDSSON, 1987; FERROGLIO et al., 2006; HALLAMAA, 2009). As there are few reports of this disease in horses in the Brazilian literature (PORTUGAL et al., 1996; SCHILD; FERREIRA; SOARES, 2003), the objective of this study was to describe the clinical and histopathological findings of insect bite hypersensitivity in horses in Brazil.

## Materials and Methods

This study included horses that were referred for evaluation to the Large Animal Clinic at the Botucatu campus of Univ. Estadual Paulista and were subsequently diagnosed with insect bite hypersensitivity. Animal selection was based on the evaluation of clinical signs and the histopathological examination of the skin lesions. The epidemiological data (the age, gender, breed and origin of the animals, management type, environment where the animal was kept, time of onset of clinical signs, disease progression, time of year when the disease occurred, prior treatments and the presence of insects) and clinical data (presence of pruritus, macroscopic aspects and lesion distribution) for all animals were determined during medical history evaluations and were recorded in individual files.

After conducting a physical examination and a specific dermatological examination, all animals were subjected to at least one incisional biopsy of the

affected area, which was performed with the animal in a standing position and under sedation with 1 mg/kg of body weight of xylazine hydrochloride and perilesional anesthesia with 2% lidocaine hydrochloride. The tissue fragments obtained were fixed in 10% buffered formalin, processed in the usual manner and embedded in paraffin. Histological sections of the paraffin blocks were cut at a thickness of 5 μm and stained using hematoxylin and eosin (HE) for subsequent examination by light microscopy. The histopathological findings of the biopsies were recorded by photomicrography, and skin scrapings were taken to evaluate the presence of fungi or mites.

## Results

There were 12 confirmed cases of IBH included in this study; the affected individuals consisted of seven males and five females with an average age of 11 years (± 5.5 years). These animals belonged to the following breeds: Quarter Horse (QH) (n=3), Mangalarga (n=3), Arabian (n=2), Brazilian Sport Horse (n=2), Criollo (n=1) and Westfalen (n=1). The animals were from ten properties located in the countryside of São Paulo state. Two animals (QH) from the same farm had been imported two years prior from the United States, and according to the information provided by the owner, the animals had never exhibited this condition prior to importation.

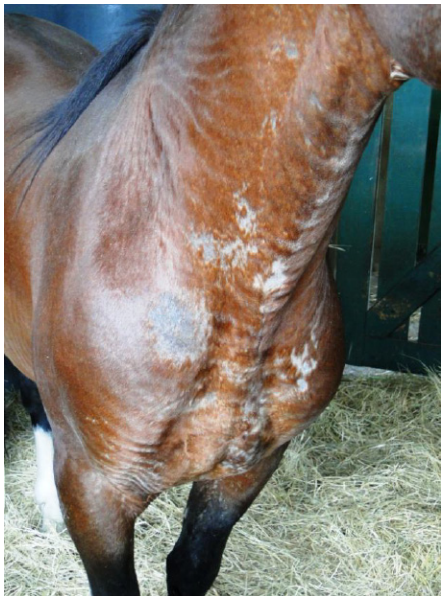
Except for two animals that were kept in paddocks, the other had been kept in stalls and placed in paddocks or training areas at certain times during the day. The first clinical signs were observed between the months of September and January (spring-summer), and the duration of disease progression varied from six to 24 months. The medical histories revealed that during this period, the animals had been treated on the properties of origin, primarily with topical and systemic antifungals due to a primary suspected diagnosis of dermatophytosis. The owners also reported the use of corticoids, antimicrobials (penicillin, nitrofurazone and sulfa drugs) and topical ixodicides (pyrethroids). All of these treatments resulted in partial clinical improvements with a temporary remission of clinical signs, although cases of relapse or clinical deterioration were always observed during the summer. In approximately 42% of the cases, the owners associated the clinical deterioration with a greater abundance of flies. Apart from skin lesions and weight loss, there were no other clinical changes reported by the owners. Furthermore, there were no additional animals showing dermatological signs similar to IBH on any of the properties examined.

The physical examinations, which were conducted between September and March, revealed signs of pruritus and alopecia; the pruritus was severe in ten animals and moderate in two other animals. Some early stage lesions were characterized by the presence of papules, hair bristling (Figure 1), pruritus and alopecia. With disease progression, the lesions coalesced and became alopecic with defined lichenified areas (Figure 2), especially in the tailhead and submandibular regions. Some areas also showed signs of excoriation associated with discrete crusts and serous or sanguineous exudates; these lesions were most likely secondary to the pruritus, which also caused signs of irritability. In all animals, this irritability was characterized by compulsive tail swishing, stomping, kicking and biting of the flanks (Figure 3).

**Figure 1.** Early lesions resulting from insect bite hypersensitivity. Papules and hair bristling can be seen in the thoracic region. Source: Authors's picture.

**Source:** Elaboration of the authors.

**Figure 2.** Insect bite hypersensitivity. Alopecia, crusts and lichenification can be seen in the chest region. Source: Authors's picture.



**Source:** Elaboration of the authors.

**Figure 3.** A horse with pruritus as a result of insect bite hypersensitivity. Source: Authors's picture.

**Source:** Elaboration of the authors.

The lesions of one animal were limited to the tailhead, two other animals demonstrated lesions on the ventral midline, and the others had diffusely distributed lesions. The base of the mane (75%) (Figure 4) and tailhead (67%) (Figure 5) were the most significantly affected areas, followed by the face (50%) (Figure 6), ventral midline (50%) and limbs (34%) (Figure 7). Scott and Miller (2003) described three types of clinical manifestations in horses in which IBH correlated with the distribution of the lesions on the bodies of the animals. According to this classification, seven animals (58.4%) exhibited the dorsal pattern (type I) of lesion distribution (the lesions were initially distributed around the mane, rump and tailhead), two animals (16.6%) displayed the ventral pattern (type II; exhibiting lesions only on the ventral region of the abdomen and thorax), and three animals (25.0%) exhibited the type III pattern (a mixture of both distribution patterns).

**Figure 4.** Insect bite hypersensitivity. Alopecia and lichenification can be seen the base of the mane. Source: Authors's picture.

**Source:** Elaboration of the authors.

**Figure 5.** Insect bite hypersensitivity. Alopecia, lichenification and broken and dry hairs can be seen at the tailhead. Source: Authors's picture.

**Source:** Elaboration of the authors.

**Figure 6.** Insect bite hypersensitivity. Alopecia, excoriations, crusts and lichenification can be seen on the face. Source: Authors's picture.

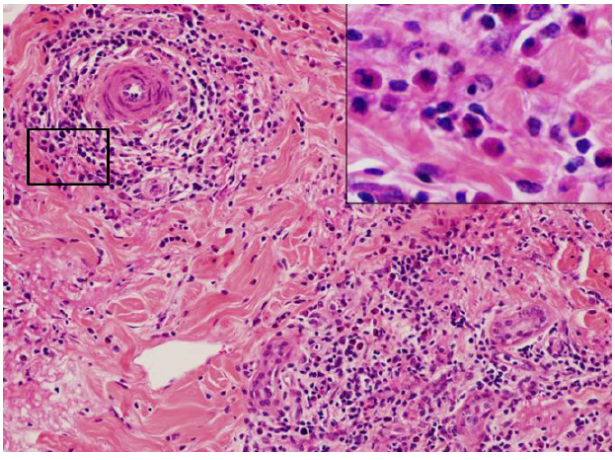
**Source:** Elaboration of the authors.

**Figure 7.** Insect bite hypersensitivity. Alopecia, crusts and lichenification can be seen in the inguinal (A), pectoral-axillary (B), axillary (C) and radioulnar (D) regions. Source: Authors's picture.


**Source:** Elaboration of the authors.

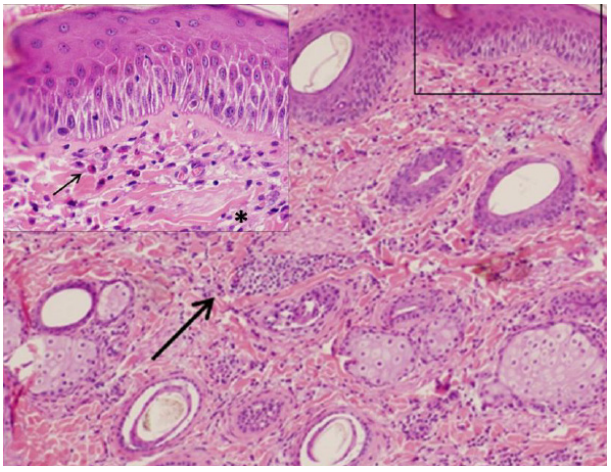
Dermatophytosis and the presence of mites were excluded after examining the material collected from the skin scrapings. The histopathological examination of the lesions revealed edema and vascular congestion with a perivascular lympho-histiocytic inflammatory infiltrate that ranged from mild to severe in the dermis. Areas with numerous eosinophils were also observed (Figure 8), as were degranulation and collagenolysis foci. The inflammation was typically perivascular and superficial, but when severe, it affected the deepest regions of the dermis (Figure 9). Mild to severe orthokeratotic hyperkeratosis, usually linked to acanthosis and spongiosis (Figure 9), was also observed in the epidermis. Ulcerations or erosion with serosanguinous or sero-fibrin-leukocyte crusts, with or without bacterial colonies and early underlying epidermal regeneration, were also frequently observed.

**Figure 8.** Histological skin section of a horse with insect bite hypersensitivity. Lympho-histiocytic inflammation with an elevated number of eosinophils is shown. HE, 10x magnification and in detail at 400x magnification. Source: Authors's picture.



**Source:** Elaboration of the authors.

**Figure 9.** Histological skin section of a horse with insect bite hypersensitivity. A site of intercellular edema (spongiosis) associated with inflammatory infiltrate foci, which are perivascular within the superficial dermis (arrows), is shown. HE, 4 x magnifications. The detailed view depicts spongiosis in the lower half of the epidermis in association with an inflammatory, eosinophilic infiltrate (arrow) and perivascular edema in the most superficial layer of the dermis (asterisk). HE, 15 x magnifications. Source: Authors's picture.



**Source:** Elaboration of the authors.

## Discussion

The highly variable age of the affected animals in this study (3 to 16 years) is similar to the findings of other reports that observed the occurrence of this disease in all age groups (KLEIDER; LEES, 1984; LITTLEWOOD, 1998; LANGNER et al., 2008; WAGNER; CHILDS; ERB, 2008). These previous authors also found that animals affected by this disease had an average age of 10 years, which is similar to the average age identified in this study. In contrast to these reports, the peak onset of clinical signs in England and Germany was shown to occur at two years and one year of age, respectively (LITTLEWOOD, 1998). However, other studies have suggested that this disease is rare in foals and that the manifestations of the first clinical signs typically occur at approximately five years of age (WILSON et al., 2001; KNOTTENBELT, 2009).

In Brazil, IBH has been described in Arabian (PORTUGAL et al., 1996) and Criollo horses (SCHILD; FERREIRA; SOARES, 2003). In the present study, the disease was detected in several breeds, with no predilection for a specific breed, as described by other authors (SCOTT; MILLER, 2003; KNOTTENBELT, 2009). Nevertheless, certain breeds have been shown to be particularly sensitive, such as the Shire Horse, the Finnhorse and the Icelandic Pony (HALLAMAA, 2009; KNOTTENBELT, 2009). As reported in the present study, this disease typically occurs as isolated cases (ANDERSON; BELTON; KLEIDER, 1988; SCHILD; FERREIRA; SOARES, 2003). However, IBH can also occur in the form of an outbreak; the study by Schild, Ferreira and Soares (2003) reported the presence of the disease in 7% of the animals on a property located in Rio Grande do Sul, Brazil.

Björnsdóttir et al. (2006) found that the greatest risk factor for IBH is exposure to *Culicoides* biting midges, especially for animals kept on fertilized or humid pastures. In the present study, the two animals imported from the United States (USA) developed the disease one year after arriving in Brazil, and IBH has been shown to be the most common skin allergy in horses in certain regions of the USA (GREINER, 1995; FRIBERG; LOGAS, 1999). Thus, epidemiological surveys must consider the origin of the animals, especially whether they have been imported, because animals imported from countries such as Iceland, where the presence of *Culicoides* biting midges has not been reported and the occurrence of this disease has not been described (BJÖRNSDÓTTIR et al., 2006; HALLAMAA, 2009; KNOTTENBELT, 2009), have been shown to be more sensitive than native animals to the development of severe hypersensitivity (BJÖRNSDÓTTIR et al., 2006; HALLAMAA, 2009). The identification of the insect species responsible for the clinical manifestations of IBH described in this study was not possible because the clinical care of the animals took place at a referral center that was far removed from the properties of origin.

The seasonality of the disease observed in the present study, in which the onset of clinical signs typically occurs between October and December, and the recurrent pattern of disease observed during the hottest months of the year are important features of IBH in horses and corroborate the concept that the disease gradually deteriorates over time and that the occurrence of clinical signs depends on the degree of insect exposure (GREINER, 1995; KNOTTENBELT, 2009) and is commonly observed during the hottest moths (FADOK; GREINER, 1990; PERRIS, 1995). Although there can be exposure to flies throughout the year in countries within the Southern Hemisphere (PERRIS, 1995), the study by Schild, Ferreira and Soares (2003) only reported the presence of IBH in horses at the beginning of the summer (January) similar to the data presented in our study. Furthermore, the onset of clinical symptoms in sheep with IBH in Southern Brazil was shown to occur mainly in the spring (SOUZA et al., 2005), whereas the disease was shown to occur during the summer and early fall in the north of Brazil (BARBOSA et al., 2011). However, both of these studies reported that some animals exhibited lesions throughout the year. The majority of animals (10/12) participating in the present study were kept in stalls but were released into paddocks at certain times of the day. This type of management increases the risk of exposure to insects because there is greater insect activity at certain times of the day, such as dawn and dusk (VAN DER RIJT et al., 2008).

The most common clinical sign of IBH is severe pruritus (PERRIS, 1995; PORTUGAL et al., 1996; FRIBERG; LOGAS, 1999; SCHILD; FERREIRA; SOARES, 2003; SCOTT; MILLER, 2003; YU, 2006). In the present study, this clinical sign was observed in all cases, and severe pruritus was reported in 84% (10/12) of animals. The alopecia observed in the animals was likely due to the chronicity of the lesions as well as the act of rubbing against obstacles and biting (KLEIDER; LEES, 1984; PORTUGAL et al., 1996; YU, 2006). Additionally, there was a

predominance of lesions at the base of the mane and the tailhead, which corroborates the findings of several studies that showed these regions as having the highest incidence of lesions (MELLOR; McCRAIG, 1974; QUINN; BAKER; MORROW, 1983; BROSTRÖM; LARSSON; TROEDSSON, 1987; LANGNER et al., 2008). Another important clinical finding of IBH in horses, the "rat tail" (YU, 2006) caused by the loss and/or breaking of hairs at the tailhead as a result of rubbing the tail against obstacles to alleviate pruritus (PORTUGAL et al., 1996; SCOTT; MILLER, 2003), was observed in 67% of animals in this study. The dorsal pattern of lesion distribution, or type I distribution (Scott & Miller 2003), was predominant in the animals examined in the present study, which seems to reflect the sites preferentially parasitized by the species of flies responsible for IBH in horses (CALVÃO-BRITO et al., 1988; GREINER, 1995).

The early clinical signs of IBH, including hair bristling and punctate areas of alopecia, are often incorrectly diagnosed as fungal or bacterial dermatitis (dermatophytosis and dermatophilosis, respectively), as reported by the owners of the animals in the present study. This misdiagnosis creates a financial problem, as funding is spent on inappropriate treatments and professional fees, and causes the deterioration of the animal's condition due to the progression and chronic nature of the IBH lesions. Unfortunately, the low sensitivity of imported tests due to the diversity of the etiological agents that can trigger IBH in horses (LANGNER et al., 2008; VAN OLDRUITENBORGH-OOSTERBAAN et al., 2009), as well as the non-existence of specific commercial tests, has made IBH difficult to diagnose in Brazil. Therefore, connecting the recurring and seasonal history of the disease with the clinical detection of skin lesions, especially in the dorsal region of the animal and often associated with severe pruritus, is an important tool for diagnosing IBH, and this combined method should also be used for the adoption of measures aimed at preventing insect contact and the relief of pruritus to minimize economic loss due to IBH.

Confirming the clinical and epidemiological findings by performing histopathological examinations of the lesions also aids with the diagnosis of IBH (SCOTT; MILLER, 2003; YU, 2006). The main histopathological findings in the animals examined in this study were similar to those described by other authors (KLEIDER; LEES, 1984; ANDERSON; BELTON; KLEIDER, 1988; PORTUGAL et al., 1996; SCHILD; FERREIRA; SOARES, 2003) and mainly consisted of epidermal orthokeratotic hyperkeratosis associated with acanthosis and spongiosis as well as dermal edema, vascular congestion and eosinophilic inflammation.

Therefore, the results of this study suggest that IBH in horses can be diagnosed safely and adequately by analyzing the epidemiological and clinical data in combination with the histopathological findings. However, it was observed that the identification of this disease remains a problem for professionals working in the field, especially for those who cannot confirm the diagnosis by histopathological examination. For this reason and due to its recurring nature, IBH represents a significant health concern for horses in different regions of the state of São Paulo.

## Acknowledgements

The authors would like to thank the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior – CAPES for awarding a National Post-Doctoral Program (Programa Nacional de Pós Doutorado – PNPD) fellowship to the first author (Oliveira-Filho J.P.) and the Conselho Nacional de Desenvolvimento Científico e Tecnológico – CNPq for awarding a research productivity grant to the last author (Borges A.S.).

## References

ANDERSON, G. S.; BELTON, P.; KLEIDER, N. The hypersensitivity of horses to culicoides bites in British Columbia. *Canadian Veterinary Journal*, Guelph, v. 29, n. 9, p. 718-723, 1988.

BARBOSA, J. D.; ALBERNAZ, T. T.; OLIVEIRA, C. M. C.; DUARTE, M. D.; OLIVEIRA, C. H. S.; BRITO, M. F.; SILVA, A. G. M. Dermatite alérgica à picada de insetos em ovinos no estado de Pará. *Pesquisa Veterinária Brasileira*, Seropédica, v. 31, n. 2, p. 117-120, 2011.

BJÖRNSDÓTTIR, S.; SIGVALDADÓTTIR, J.; BROSTRÖM, H.; LANGVAD, B.; SIGURÐSSON, A. Summer eczema in exported Icelandic horses: influence of environmental and genetic factors. *Acta Veterinaria Scandinavica*, London, v. 48, n. 3, p. 1-4, 2006.

BROSTRÖM, H.; LARSSON, A.; TROEDSSON, M. Allergic dermatitis (sweet itch) of Icelandic horses in Sweden: an epidemiological study. *Equine Veterinary Journal*, Hobokken, v. 19, n. 3, p. 229-236, 1987.

CALVÃO-BRITO, R. H. S.; RODRIGUES, M. L. A.; MOKRABE, E. M.; MAIA-HERZOG, M.; MELLO, R. P.; SILVA-JÚNIOR, V. P. Oncocercose eqüina: diagnóstico e verificação da hematofagia por simulídeos e culicóides, prováveis vetores no Rio de Janeiro, Brasil. *Revista Brasileira Zoologia*, Curitiba, v. 15, n. 3, p. 583-587, 1988.

CORRÊA, T. G.; FERREIRA, J. M.; RIET-CORREA, G.; RUAS, J. L.; SCHILD, A. L.; RIET-CORREA, F.; GUIMARÃES, A.; FELIPPE-BAUER, M. L. Seasonal allergic dermatitis in sheep in southern Brazil caused by *Culicoides insignis* (Diptera: *Ceratopogonidae*). *Veterinary Parasitology*, Amsterdam, v. 145, n. 1-2, p. 181-185, 2007.

FADOK, V. A.; GREINER, E. C. Equine insect hypersensitivity: skin test and biopsy results correlated with clinical data. *Equine Veterinary Journal*, Hobokken, v. 22, n. 4, p. 236-240, 1990.

FERROGLIO, E.; PREGEL, P.; ACCOSSATO, A.; TARICCO, I.; BOLLO, E.; ROSSI, L.; TRISCIUOGLIO, A. Equine Culicoides hypersensitivity: evaluation of a skin test and of humoral response. *Journal of Veterinary Medicine A., Physiology, Pathology, Clinical Medicine*, Berlin, v. 53, n. 1, p. 30-33, 2006.

FREY, R.; BERGVALL, K.; EGENVALL, A. Allergen-specific IgE in Icelandic horses with insect bite hypersensitivity and healthy controls, assessed by FceR1a-based serology. *Veterinary Immunology Immunopathology*, Amsterdam, v. 126, n. 1-2, p.102-109, 2008.

FRIBERG, C. A.; LOGAS, D. Treatment of culicoides hypersensitive horses with high-dose n-3 fatty acids: a double-blinded crossover study. *Veterinary Dermatology*, Oxford, v. 10, n. 2, p. 117-122, 1999.

GREINER, E. C. Entomologic evaluation of insect hypersensitivity in horses. *Veterinary Clinics North America, Equine Practice*, Philadelphia, v. 11, n. 1, p. 29-41, 1995.

HALLAMAA, R. E. Characteristics of equine summer eczema with emphasis on differences between Finnhorses and Icelandic horses in a 11-year study. *Acta Veterinaria Scandinavica*, London, v. 51, n. 29, p. 1-6, 2009.

HELLBERG, W.; MELLOR, P. S.; TORSTEINSDÓTTIR, S.; MARTI, E. Insect bite hypersensitivity in the horse: Comparison of IgE-binding proteins in salivary gland extracts from *Simulium vittatum* and *Culicoides nubeculosus*. *Veterinary Immunology Immunopathology*, Amsterdam, v. 132, n. 1, p. 62-67, 2009.

KLEIDER, N.; LEES, M. J. Culicoides hypersensitivity in the horse: 15 cases in Southwestern British Columbia. *Canadian Veterinary Journal*, Guelph, v. 25, n. 1, p. 26-32, 1984.

KNOTTENBELT, D. C. *Pascoe's principles and practice of equine dermatology.* Philadelphia: W.B. Saunders, 2009. 520 p.

LANGNER, K. F. A.; DARPEL, K. E.; DROLET, B. S.; FISCHER, A.; HAMPEL, S.; HESELHAUS, J. E.; MELLOR, P. S.; MERTENS, P. P. C.; LEIBOLD, W. Comparison of cellular and humoral immunoassays for the assessment of summer eczema in horses. *Veterinary Immunology Immunopathology*, Amsterdam, v. 122, n. 1-2, p. 126-137, 2008.

LITTLEWOOD, J. D. Incidence of recurrent pruritus ("sweet itch") in British and German shire horses. *Veterinary Record*, London, v. 142, n. 3, p. 66-67, 1998.

McCAIG, J. A survey to establish the incidence of sweet itch in Ponies in the United Kingdom. *Veterinary Record*, London, v. 93, n. 16, p. 444-446, 1973.

MELLOR, P. S.; McCRAIG, J. The probable cause of "sweet itch" in England. *Veterinary Record*, London, v. 95, n. 18, p. 411-415, 1974.

PERRIS, E. E. Parasitic dermatoses that cause pruritus in horses. *Veterinary Clinics North America Equine Practice*, Philadelphia, v. 11, n. 1, p. 11-28, 1995.

PORTUGAL, M. A. S. C.; GUERRA, J. L.; BALDASSI, L.; FERNANDES, N. S.; CALIL, E. M. B. Dermatite estival recidivante em eqüinos. *Arquivos Instituto Biológico*, São Paulo, v. 63, n. 1, p. 1-6, 1996.

QUINN, P. J.; BAKER, K. P.; MORROW, A. N. Sweet itch: responses of clinically normal and affected horses to intradermal challenge with extracts of biting insects. *Equine Veterinary Journal*, Hobokken, v. 15, n. 3, p. 266-272, 1983.

SCHAFFARTZIK, A.; WEICHEL, M.; CRAMERI, R.; BJÖRNSDÓTTIR, P. S.; PRISI, C.; RHYNER, C.; TORSTEINSDÓTTIR, S.; MARTI, E. Cloning of IgE-binding proteins from *Simulium vittatum* and their potential significance as allergens for equine insect bite hypersensitivity. *Veterinary Immunology Immunopathology*, Amsterdam, v. 132, n. 1, p. 68-77, 2009.

SCHILD, A. L.; FERREIRA, J. L.; SOARES, M. P. *Boletim do laboratório regional de diagnóstico*. Pelotas: Gráfica Universitária UFPEL, 2003, 40 p.

SCOTT, D. W.; MILLER, W. H. *Equine dermatology*. St. Louis: W.B. Saunders, 2003. 823 p.

SOUZA, T. M.; FIGHERA, R. A.; PIAZER, J. V.; BARROS, C. S. L.; IRIGOYEN, L. F. Dermatite alérgica sazonal em ovinos. *Ciência Rural*, Santa Maria, v. 35, n. 2, p. 475-477, 2005.

VAN DER RIJT, R.; VAN DEN BOOM, R.; JONGEMA, Y.; VAN OLDRUITENBORGH-OOSTERBAAN, M. M. S. Culicoides species attracted to horses with and without insect hypersensitivity. *Veterinary Journal*, London, v. 178, n. 1, p. 91-97, 2008.

VAN OLDRUITENBORGH-OOSTERBAAN, M. M. S.; VAN POPPEL, M.; DE RAAT, I. J.; VAN DEN BOOM, R.; SAVELKOUL, H. F. J. Intradermal testing of horses with and without insect bite hypersensitivity in the Netherlands using an extract of native Culicoides species. *Veterinary Dermatology*, Oxford, v. 20, n. 5-6, p. 607-614, 2009.

WAGNER, B.; CHILDS, B. A.; ERB, H. N. A histamine release assay to identify sensitization to Culicoides allergens in horses with skin hypersensitivity. *Veterinary Immunology Immunopathology*, Amsterdam, v. 126, n. 3-4, p. 302-308, 2008.

WAGNER, B.; MILLER JUNIOR, W. H.; ERB, H. N.; PAUL LUNN, D.; ANTCZAK, D. F. Sensitization of skin mast cells with IgE antibodies to Culicoides allergens occurs frequently in clinically healthy horses. *Veterinary Immunology Immunopathology*, Amsterdam, v. 132, n. 1, p. 53-61, 2009.

WILSON, A. D.; HARWOOD, L. J.; BJÖRNSDOTTIR, S.; MARTI, E.; DAY, M. J. Detection of IgG and IgE serum antibodies to Culicoides salivary gland antigens in horses with insect dermal hypersensitivity (sweet itch). *Equine Veterinary Journal*, Hobokken, v. 33, n. 7, p. 707-713, 2001.

YERUHAM, I.; BRAVERMAN, Y.; ORGAD, U. Field observations in Israel on hypersensitivity in cattle, sheep and donkeys caused by *Culicoides*. *Australian Veterinary Journal*, Sydney, v. 70, n. 9, p. 348-352, 1993.

YU, A. A. Insect hypersensitivity. *AAEP Proceedings*, Lexington, v. 52, n. 1, p. 490-492, 2006.