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(RESEARCH ARTICLE)

Description and study of the Hippoboscidae Family Samouelle, 1819. (Insecta: Diptera)

Carlos Henrique Marchiori *

Goiano Federal Institute, Biological Sciences, Parasitology. Goiânia, Goiás, Brazil.

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Abstract

Hippoboscidae Samouelle, 1819 is a family of flies (Diptera) consisting of species that are obligatory parasites of several species of mammals and birds. The family includes winged species, with good or reasonable flight capacity, and species with vestigial or even absent wings, incapable of flight and with strong apomorphy. The objective of this collection consists of bibliographical research on the Muscoid dipterans of the Hippoboscidae Family. The research was carried out in studies related to quantitative aspects of the Family, Subfamily and Species (taxonomic groups) and conceptual aspects such as: biology, geographical distribution, methodologies, species, life cycle, damage, economic importance, medicinal importance, biological aspects, monitoring and control and reproduction. A literature search was carried out containing articles published from 1940 to 2021. The mini-review was prepared in Goiânia, Goiás, from September to October 2021, through the. The mini-review was prepared in Goiânia, Goiás, from September to October 2021, through the Online Scientific Library (Scielo), internet, ResearchGate, Academia.edu, Frontiers, Publons, Qeios, Portal of Scientific Journals in Health Sciences, Pubmed, Online Scientific Library (Scielo), internet, ResearchGate, Academia.edu, Frontiers, Biological Abstract, Publons, Qeios, Portal of Scientific Journals in Health Sciences, and Pubmed, Dialnet, World, Wide Science, Springer, RefSeek, Microsoft Academic, Science, ERIC, Science Research.com, SEEK education, Periódicos CAPES, Google Academic, Bioline International, VADLO, Scopus, and Web of Science.

Keywords: Insect; Dipterans; Myases; Disease; Vectors

1. Introduction

Hippoboscidae Samouelle, 1819 is a family of flies (Diptera) consisting of species that are obligatory parasites of several species of mammals and birds. The family includes winged species, with good or reasonable flight capacity, and species with vestigial or even absent wings, incapable of flight and with strong apomorphy. As is common among other members of the Hippoboscoidea superfamily, most larval development occurs within the maternal body, with pupation occurring almost immediately (Figure 1A and 1B) [1].

Hippoboscidae are hematophagous flies that have a generally broad and flat body dorsoventrally; they have a small head and closely juxtaposed to the prothorax, existing, in turn, winged, apterous or vestigial forms, in addition to the presence of legs with strong claws intended for attachment to the host's hair or feathers [1].

These diptera are found in all biogeographic regions, parasitizing birds and mammals including domestic and wild birds, as well as sheep, horses and other wild mammals of the Bovidae family [1]

* Corresponding author: Carlos Henrique Marchiori
Goiano Federal Institute, Biological Sciences, Parasitology. Goiânia, Goiás, Brazil.

Source: https://pt.wikipedia.org/wiki/Hippoboscidae

Figure 1A Hippoboscidae Samouelle, 1819

Source: https://pt.wikipedia.org/wiki/Hippoboscidae

Figure 1B Hippoboscidae Family Samouelle, 1819

The Hippoboscidae family includes species with very different morphological characteristics, reflecting the adaptation to different hosts, since all species are obligate hematophagous ectoparasites of mammals and birds. The species *Melophagus ovinus* (Linnaeus, 1758), which parasitizes sheep, is apterus (wingless), with a reddish-brown color. The Neotropical species *Lipoptena mazamae* (Rondani, 1878), is a common ectoparasite of the Fallo *Odocoileus virginianus* Zimmermann, 1780 in the southeastern United States (Figure 2) [2].

In the group coexist winged and apterus species. A common winged species is *Equine hippobosca* Linnaeus, 1758, an equine parasitic fly, common in domestic horses. Some species are common parasites of birds, such as *Ornithomya* Bequaerti, which was collected from birds in Alaska. Two species of Hippoboscidae – *Ornithoica (Ornithoica) podargi* Maa, 1966 and *Ornithomya fuscipennis* Bigot, 1885 are frequent parasites of *Podargus strigoides* (Latham, 1801) from Australia. *Pseudolynchia canariensis* (Macquart, 1839) is a frequent parasite of pigeons and doves and can serve as a vector for pigeon malaria. There is evidence pointing to Hippoboscidae as vectors of mammalian diseases (Figure 3) [3]

Source: https://pest.bigbadmole.com/en/muhi/o-muhah/chto-budet-esli-sest-yajca-muhi/

Figure 2 Egg, Larva1, 2 and 3, Pupa and Male and Female of the Hippoboscidae Family

Source: Egg, Larva, Pupa and Male and Female of the Hippoboscidae Family

Figure 3 What will happen if you eat the eggs of a fly, depends on the variety of the body's immune system, individual characteristics of the digestive system. In most cases, nothing bad happens. But there are species of whose larvae live under human skin and cause myiasis. Their removal requires surgical intervention, there can be serious consequences

The name Hippoboscidae was applied to the group currently known as Pupipara, which corresponds to the currently accepted delineation for the family but dropped to the groups Nycteribiidae and "Streblidae" (parasitic bat flies). Although this delimitation is obsolete given the available taxonomic knowledge, it continues to be used in some works. Two of the three subfamilies traditionally considered, the Hippoboscinae and Lipopteninae subfamilies, were shown to be monophyletic groupings, at least when considered broadly. Cladistic analysis of various DNA sequences has shown that to make the monophyletic Ornithomyinae grouping, the tribe Olfersini must also be considered as a family. Based on these considerations, the Hippoboscidae family assumes the following delimitation:

1-Subfamily Ornithomyinae Bigot, 1853, Genus *Allobosca* Speiser, 1899 (1 species), Genus *Austrolfersia* Bequaert, 1953 (1 species), Genus *Crataerina* von Olfers, 1816 (8 species), Genus *Icosta* Speiser, 1905 (52 species), Genus *Microlynchia* Lutz, 1915 (4 species), Genus *Myophthiria* Róndani, 1875 (13 species), Genus *Olfersia* Leach, 1817 (7 species), Genus *Ornithoctona* Speiser, 1902 (12 species), Genus *Ornithoica* Róndani, 1878 (24 species), Genus *Ornithomya* Latreille, 1802 (29 species) Genus *Ornithophila* Róndani, 1879 (2 species), Genus *Ortholfersia* Speiser, 1902 (4 species), Genus *Phthona* Maa, 1969 (3 species), Genus *Proparabosca* Theodor & Oldroyd 1965 (1 species), Genus *Pseudolynchia,* Bequaert, 1926 (5 species) and Genus *Stilbometopa* Coquillett, 1899 (5 species) (Figure 4a and 4b).

Source: https://bugguide.net/node/view/223659/bgpage

Figure 4A Subfamily Ornithomyinae

Figure 4B Genus *Pseudolynchia*, Bequaert, 1926

2-Hippoboscinae subfamily, Genus *Hippobosca* Linnaeus, 1758 (7 species) and Genus *Struthibosca* Maa, 1963 (1 species) (Figure 5 and 6).

Source: https://alchetron.com/Hippobosca#hippobosca-edc2b94c-f4be-472c-95dd-50ccdd80e22-resize-750.jpg

Figure 5 Hippoboscinae subfamily

Source: https://alchetron.com/Hippobosca

Figure 6 Genus *Hippobosca* Linnaeus, 1758

3-Lipopteninae subfamily, Genus *Lipoptena* Nitzsch, 1818 (30 species), Genus *Melophagus* Latreille, 1802 (3 species) and Genus *Neolipopte* ESP/Botucatu (SP) for identification and information [3,4].

1.1. Objective

Description and study of the Hippoboscidae Family Samouelle, 1819 (Insecta: Diptera)

2. Methods

The research was carried out in studies related to quantitative aspects of the Family and Species (taxonomic groups) and conceptual aspects such as: geographical distribution, hosts, species, life cycle and reproduction. A literature search was carried out containing articles published from 1947 to 2021. The research was carried out in studies related to quantitative aspects of the Family, Subfamily and Species (taxonomic groups) and conceptual aspects such as: biology, geographical distribution, methodologies, and traps for collecting and their parasitoids and species, life cycle, damage, economic importance, medicinal importance, biological aspects, monitoring and control and reproduction. A literature search was carried out containing articles published from 1993 to 2021. The mini-review was prepared in Goiânia, Goiás, from September to October 2021, through the. The mini-review was prepared in Goiânia, Goiás, from September to October 2021, through the Online Scientific Library (Scielo), internet, ResearchGate, Academia.edu, Frontiers, Publons, Qeios, Portal of Scientific Journals in Health Sciences, Pubmed, Online Scientific Library (Scielo), internet, ResearchGate, Academia.edu, Frontiers, Biological Abstract, Publons, Qeios, Portal of Scientific Journals in Health Sciences, and Pubmed, Dialnet, World, Wide Science, Springer, RefSeek, Microsoft Academic, Science, ERIC, Science Research.com, SEEK education, Periódicos CAPES, Google Academic, Bioline International, VADLO, Scopus, and Web of Science.

3. Description of studies performed

3.1. Study 1

The Hippoboscidae family comprises about 200 species distributed in 21 genera, in three subfamilies. It is found in all biogeographic regions, parasitizing birds and some orders of mammals performed the synopsis of the hypoboscides found in Brazil, providing an identification key for eight genera and diagnosis of 14 species. Since then, they have added a lot of information about species distribution and host association. Currently, 30 species in 10 genera are found in Brazil. However, there is still little information on distribution and hosts in all regions of the country (Figure 7) [5,6,7]

Source: https://bugguide.net/node/view/223658/bgpage

Figure 7 Lipopteninae subfamily

The *Melophagus ovinus* L. 1758 is a hematophagous insect of the Hippoboscidae Family (pupiparous dipteran) that mainly parasitizes sheep. It is an apterous (wingless) fly, with a flattened body and covered with hair, dark in color and with three pairs of articulated thoracic legs and claws, about 5 to 7 mm in length. This is one of the most cosmopolitan and frequent parasites of sheep in different countries, especially in temperate and cold areas and restricted to high and mountainous areas in the tropics (Figure 8) [7,8,9,10].

Source: https://bugguide.net/node/view/342573/bgpage

Figure 8 Genus *Lipoptena*

3.2. Study 2

Known as a "false tick" in our country, the melophagus is distributed in Catamarca, Jujuy, Tucumán, Salta, in Buenos Aires, but mainly in Patagonia since Rio Negro to the southern tip of the continent. Its finding has been constant in the humid areas of the foothills and southern Santa Cruz and Tierra del Fuego, but in recent years, it has had a dispersion that also affects the flocks of the arid plateau and Atlantic coast, estimating that 70% of Patagonian sheepfolds are affected by melophages. This dispersion has been attributed to the fact that livestock keepers have abandoned the antisárnic baths before the option of the systemic injectables since the majority of these, applied as scabies, do not eradicate the melophages (Figure 9). [11,12,13]

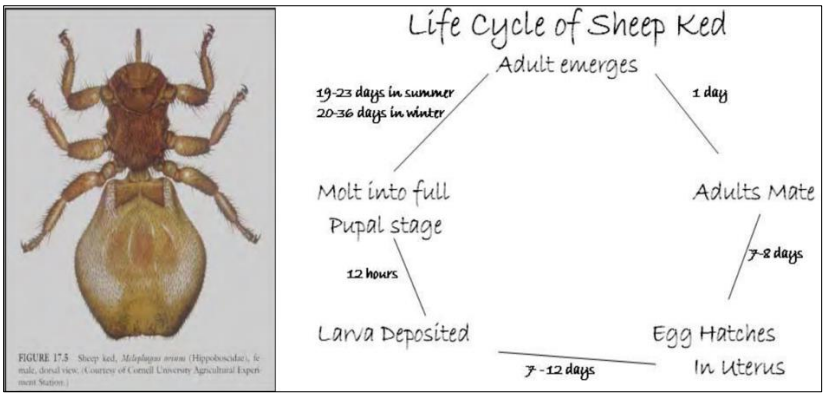
Source: https://en.wikipedia.org/wiki/Melophagus_ovinus

Figure 9 *Melophagus ovinus* L.,1758

Additionally, the scarce symptoms do not allow early diagnosis in extensive sheep farming systems, this means that light infestations and treatment failures are generally detected at shearing. Although the sheep is considered the only definitive host, the melophagus has been found in other domestic and wild animals, such as goats, bison, rabbits, dogs, humans, foxes, and camelids [14,15].

3.3. Study 3

Biological Cycle *Melophagus ovinus* L., 1758 are obligate and permanent parasites; the entire cycle develops in the fleece, on the host's skin, with little ability to survive in the external environment, so transmission it is produced mainly by direct contact with parasitized animals. The egg, (unlike most dipterans) matures in the female's abdomen and transforms into a larva, the first being expelled as a chrysalis at 8 to 12 days, with subsequent repetitions every 8 to 12 days (Figure 10) [14,15,16].



Source: https://www.semanticscholar.org/paper/Experimental-Study-on-Sheep-Infested-With-Bovicola-Getachew/a115f3ffd004b44a43f16afe38e1d5e3f4d17d3a

Figure 10 Life cycle of the *Melophagus ovinus* L. 1758

The chrysalis evolves in 12 hours to pupa, chestnut-brown in color that is deposited in the wool 1-2 cm from the skin. These brownish sacs can measure up to 4 mm (2/3 the size of the adult melophagus) and are easy to see with the naked eye. In general, it is assumed that each female, in a period of 4 to 5 months, oviposits 12 to 15 times, although demonstrated that in Europe they barely oviposit 5 to 6 times in one cycle of approximately 50 days of life [15,16].

The larvae emerges from the sac between 19 to 24 days later with that observed in Patagonia), and between 6 to 7 days it reaches an adult, with the particularity that the female can be fertilized from 16 hours of emergence. The evolution to complete the cycle has a variable duration of 24 to 42 days. Although the biological cycle is carried out exclusively on sheep, in mixed grazing in Patagonia, there are records of goats infested by adult melophagi, but without findings of pupae that indicate that they complete the cycle [15,16].

The bites they make to feed themselves cause irritation in the host with visible lesions that devalue the leather, although records are scarce, in very serious cases weight loss and deterioration have been reported. of the general state of the animal, as well as differences in production and yield), of wool the evaluations on the economic effects are contradictory, since there are several authors who could not find productive differences between groups of sheep with and without parasites (Figure 11) [17,18].

Source: researchgate.net/figure/Sheep-from-Yahazhen-of-Kuqa-in-Xinjiang-in-June-2017-a-M-ovinus-parasitizes-sheep-in_fig1_324619606

Figure 11 Sheep from Yahazhen of Kuqa in Xinjiang in June 2017. a. *Melophagus ovinus* L., 1758, parasitizes sheep in fur. *M. ovinus* could be found in the fur-covered area all over the body, including ears (and behind the ears), neck, chest, abdomen, back, breech, legs, and tail. b. Adult *M. ovinus* c. Pupal *M. ovinus*

In general, it is accepted that moderate to high infestations (averages greater than 260 melophages per group), in sheep with a low nutritional level, produce differences in wool production of 11% between sheep and pair years, differences of weight in fattening lambs and deterioration of the leather value. It is noteworthy that although there are objective quality measures to market trained. Simultaneously, uncontrolled farm income must be avoided, and good perimeter wires should be provided, as well as requiring the disinfection of machinery and accessories used for shearing [17,18].

3.4. Study 5

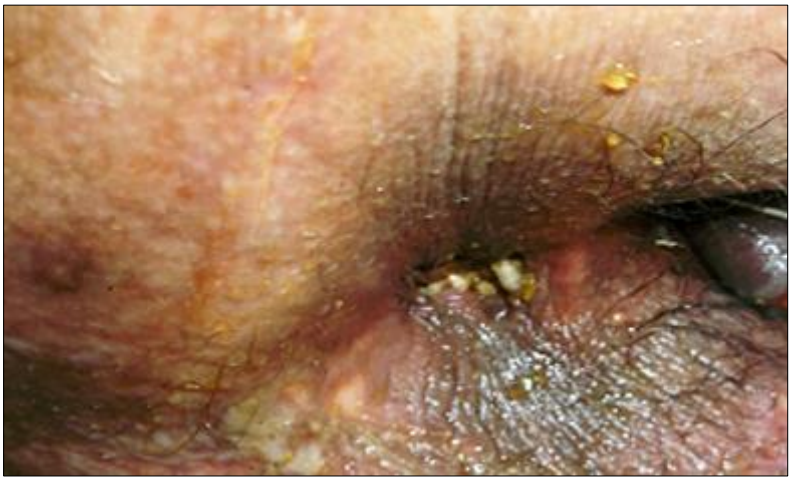
3.4.1. Myases

Serious diseases cause gray larvae meat flies, wolfarth. Eggs enter the body with food, in the presence of diseases of the digestive tract, weak immunity, they are not digested, enter the systemic circulation. Over time, they are localized in different internal organs (Figure 12).

Source: https://austinpublishinggroup.com/clinical-case-reports/fulltext/ajccr-v1-id1039.php
Source: Source: researchgate.net/figure/Sheep-from-Yahazhen-of-Kuqa-in-Xinjiang-in-June-2017-a-M-ovinus-parasitizes-sheep-in_fig1_324619606

Figure 12 Oral myiasis

In the intestines, parasites stay for several days, go outside with vomit, feces. Localization in the urethra provokes pain during urination, requires rinsing the organ, removing the larvae. Parasitization in other organs disrupts their functioning, causes diseases, the cause of which is difficult to diagnose. Staying in the eyeball is dangerous with partial or complete loss of vision. Removed surgically (Figure 13) [19]



Source: https://onlinelibrary.wiley.com/doi/full/10.1002/jgf2.247

Figure 13 Intestinal myiasis in a very elderly patient with inappropriate home care

In the human body, larvae never pass full development cycle, but during their life can cause significant harm. Swallowing eggs due to their small size is quite simple, so you need to pay special attention to the place of eating, the quality of the dishes, eat only fresh products. Egg laying only occurs on products that begin to deteriorate, storage conditions are violated [19].

3.5. Study 6

3.5.1. Intestinal Myiasis -- Washington

In June and August 1984, the mother of a 12-month-old Washington girl periodically observed "moving worms" in the child's stool. The child was asymptomatic. She was treated by her physician for a presumptive diagnosis of pinworm infection, first with pyrvinium pamoate and then with piperazine. However, the mother continued to see "worms" in the child's stool. In early September, fly larvae (maggots) were seen in each of two stool specimens collected on different

days. These larvae were identified as living third instars of *Muscina stabulans* (Fallén, 1817) (Diptera, Muscidae) Stable fly. (Figure 14) [20,21].

Figure 1: 'Myiasis-in-ano': The anal canal of the patient revealed maggots with cylindrical bodies and dark peritremes at the caudal end

Source: https://www.researchgate.net/figure/Treatment-of-anogenital-warts-with-SADBE-patient-data_tbl2_11204887

Figure 14 Intestinal Myiasis

Myiasis is the infestation of live human and vertebrate animals with fly (dipterous) larvae, which, at least for a certain period, feed on dead or living tissue or ingested food of the host. Intestinal myiasis occurs when fly eggs or larvae previously deposited in food are ingested and survive in the gastrointestinal tract. Some infested patients have been asymptomatic; others have had abdominal pain, vomiting, and diarrhea (Figure 15) [25,26]

Source: https://www.researchgate.net/figure/Extensive-destructive-lesion-of-the-maxillary-orbital-region-of-the-face-with-a-lot-of_fig1_290436377

Figure 15 Extensive destructive lesion of the maxillary- orbital region of the face with a lot of larvae inside

The finding of fly larvae in stool specimens does not necessarily denote intestinal myiasis. Many species of fly larvae that might be accidentally ingested with food cannot survive in the gastrointestinal environment. In such cases, although the dead larvae may be recognized on subsequent stool examinations, true host infestation is never established, and the condition is properly termed pseudomyiasis. Pseudomyiasis can also occur when female flies oviposit on uncovered fecal specimens before laboratory processing (Figure 16) [27,28,29].

Source: http://www.atlasdermatologico.com.br/disease.jsf?diseaseId=311

Figure 16 Myiasis is the infestation of live human

In addition to the intestine, myiasis can occur in other anatomic sites, including skin, eye, ear, nasopharynx, and the genitourinary tract; infestation may also occur in wounds. Over 50 fly species have been reported to cause human myiasis. Treatment of all forms of myiasis includes occlusive salves and dressings for cutaneous myiasis manual removal of larvae in aural, genitourinary, and nasopharyngeal myiasis (Figure 17) [29].

Source: http://www.atlasdermatologico.com.br/disease.jsf?diseaseId=311

Figure 17 Myiasis-Furuncular

In nine (38%) of these, the larvae were found on stool examination. Four cases (17%) were cutaneous: three (13%), aural; one (4%), urinary; one (4%), nasopharyngeal; and six (25%), from unspecified sites. In a summary of 102 myiasis cases reported during the 11-year period 1952-1962 from 29 states, Canada, and Puerto Rico, 38 cases were cutaneous; 28 were enteric; and 46 involved other anatomic sites (nasopharyngeal, ocular, aural, and wound). Sixty-five percent of cases occurred during the warmer months (April through September), when fly populations are at their greatest (4). Myiasis has occasionally been reported as a hospital-acquired infection; case reports of these infections in obtunded intensive-care unit and convalescent home patients have recently been published [30].

3.6. Study 7

3.6.1. ***Louse-flies (Family Hippoboscidae).***

Genera of importance are *Melophagus* and *Hippobosca*. This is a Family of specialized blood feeding flies with a reproductive cycle similar that described for tsetse-flies. They are often known as louse-flies because some species shed their wings when as adults they find a host after active flying (in genus *Lipoptena*).

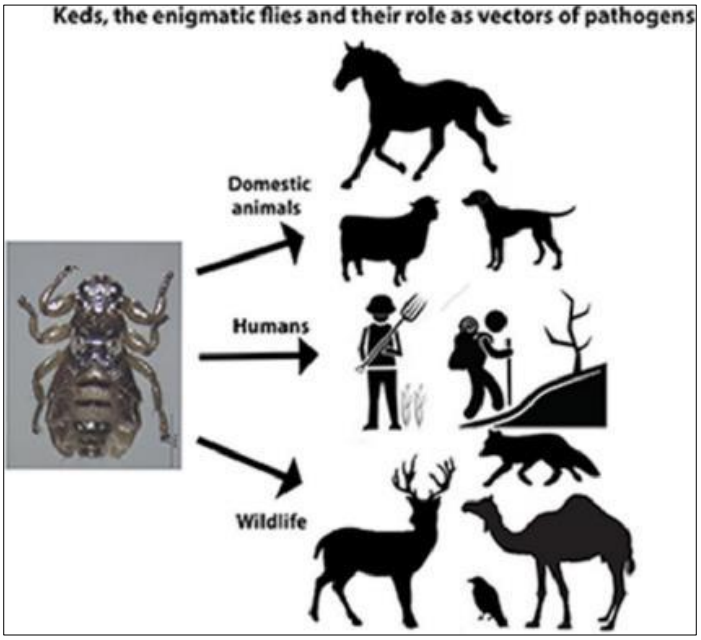
Alternatively flies of genus *Melophagus* are so adapted to parasitism that the adults never develop wings. Louse-flies without wings may appear like ticks, but the only stage of tick seen with three pairs of legs will be larvae these are much smaller than louse-flies (Figure 18) [31].

Source: *Hippobosca* sp. are large, robust flies that retain their wings to fly for repeated blood meals, between hosts such as cattle, camels, or horses in a herd

Figure 18 Adults of the genus Hippobosca

3.7. Morphology, life cycle, hosts and feeding.

Adults of the genus *Hippobosca* are large, robust flies that retain their wings to fly for repeated blood meals, between hosts such as cattle, camels, or horses in a herd. Stout piercing mouthparts project downward from the head (see *Hippobosca* in Gallery). The abdomen bulges largely, especially when containing a developing larva. The life cycle is the larviparous type, similar to that of tsetse-flies, few offspring are produced per female but their survival rate is high. In species that never develop wings as adults, such as *Melophagus ovinus* L., 1758, the sheep-ked, the fully developed larvae are deposited by the female on the hair coat of the host. There pupation occurs rapidly followed by complete metamorphosis into an adult (see photograph of *Melophagus*) (Figure 19) [32].

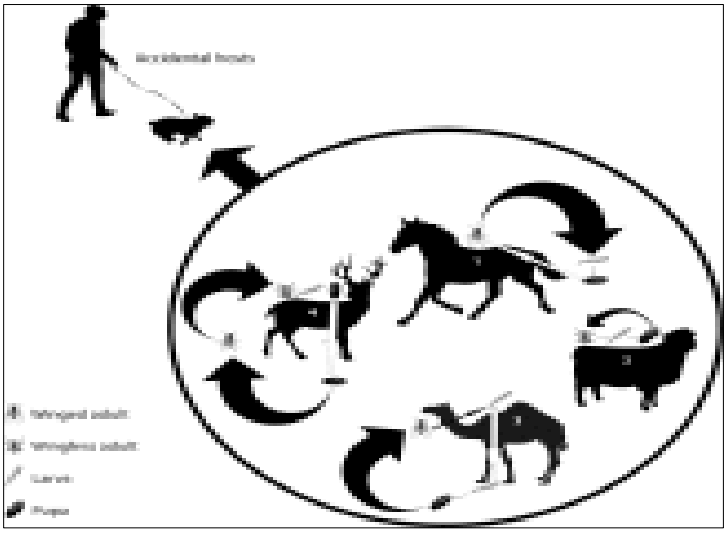


Source: *Hippobosca* are large, robust flies that retain their wings to fly for repeated blood meals, between hosts such as cattle, camels, or horses in a

Figure 19 *Hippobosca equina* as vectors of pathogens

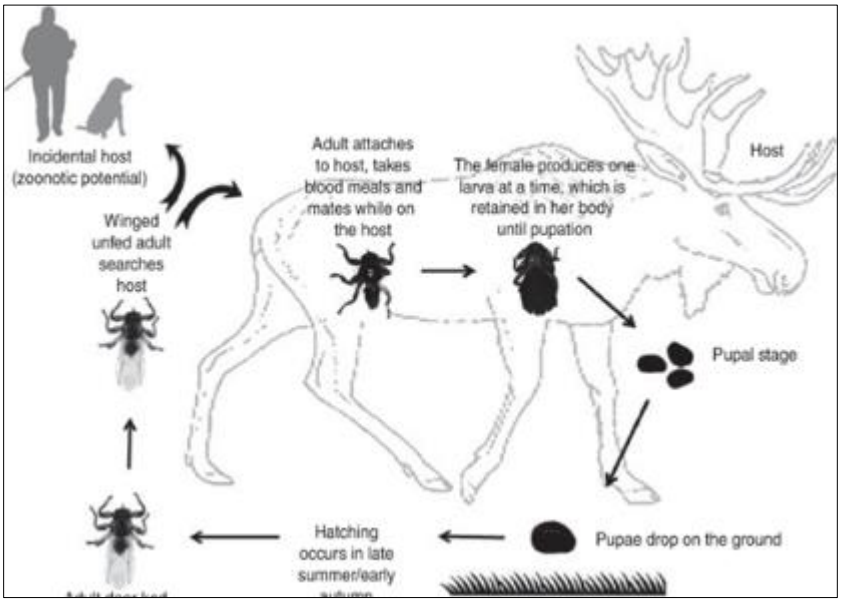
3.8. Parasitic diseases and transmitted organisms.

Irritation and biting-stress is caused. Damage to skin results in poor quality of leather when hides are processed, a condition known as cockle. Sheep-keds transmit the bacterium *Eperythrozoon ovis* D'sakonov, L, P., 1968, to sheep and this infection may cause fever and anemia. They also transmit *Trypanosoma melophagium* Flu, 1908, but this protozoan seems non-pathogenic (Figure 20, 21 and 22) [33,34]



Source: https://www.sciencedirect.com/science/article/abs/pii/S0001706X20305027

Figure 20 This led to a scarce scientific knowledge about their biology, ecology, behavior, and epidemiology as well as vector competence. However, the life history of some hippoboscid species, e.g., *M. ovinus, Lipoptena cervi* L. 1758, and *Hippobosca equine* L. 1758, suggests that these ectoparasites are important candidates to vector infectious disease agents (e.g., *Rickettsia* spp., *Borrelia* spp., *Bartonella* spp., *Anaplasma phagocytophilum, Theileria ovis* (du Tiot, 1918) (Piroplasmida: Theileriidae). Indeed, the peculiar biological and behavioral traits (i.e., obligatory blood sucking and reproductive physiology) of many ked species make them a suitable pabulum for pathogen's multiplication and for their transmission to receptive hosts. Therefore, studies focusing on the ked bio-ecological aspects as well as on their vector role are advocated along with the control of keds affecting different animal species. This review.



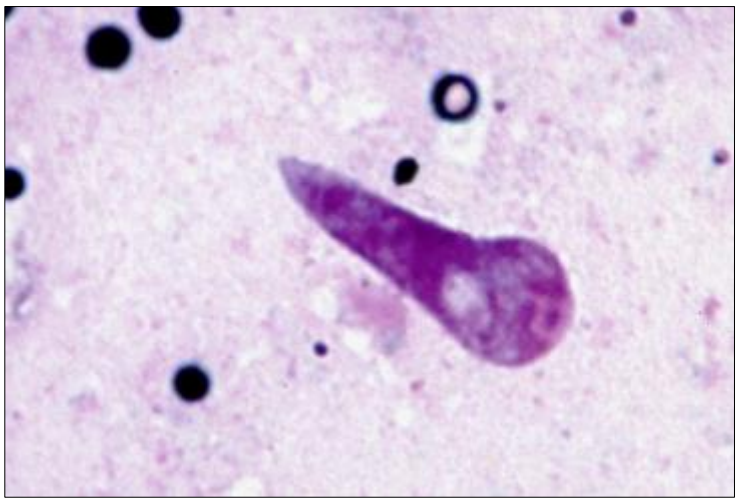
Source: Schematic overview of the deer ked life cycle

Figure 21 Parasitic diseases and transmitted organisms

Source: https://www.mediastorehouse.com/ardea-wildlife-pets-environment/dec2014/6/deer-fly-fur-10461574.html

Figure 22 Framed print of deer fly - on fur *Lipoptena cervi* (L. 1758) (Diptera: Hippoboscidae)

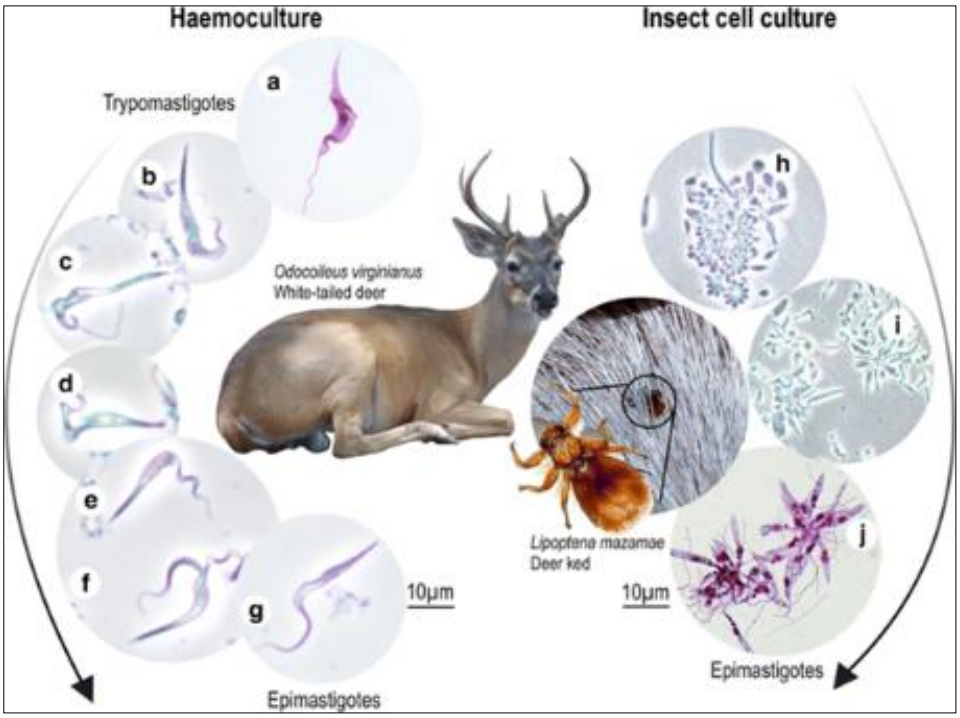
Theileriosis, caused by various intra erythrocytic protozoan parasites of the genus *Theileria*, is a tick – borne disease of domestic and wild animals. *Ovine theileriosis* (MOT) is an important hemoprotozoal disease of sheep and goats in tropical and subtropical regions that leads to economic losses in these animals. *Theileria ovis* R. bursa (Piroplasmida: Theileriidae) is considered as less pathogenic, but clinical disease may occur in stressful situations related to translocation of animals or/and when a host is debilitated by other parasitic organisms or malnutrition (Figure 23) [35]



Source: https://en.wikipedia.org/wiki/Theileriidae

Figure 23 Kinet stage of *Theileria*

Trypanosoma (Megatrypanum) melophagium is a sheep parasite transmitted by sheep keds, the ectoparasite restricted to sheep *Melophagus ovinus* (Linnaeus 1758), (Diptera: Hippoboscidae). Sheep keds were 100% prevalent in sheep from five organic farms in Croatia, Southeast Europe, while trypanosomes morphologically compatible with *T. melophagium* were 86% prevalent in the intestine of sheep keds (Figure 24 and 25) [36].



Source: https://parasitesandvectors.biomedcentral.com/articles/10.1186/s13071-020-04169-0

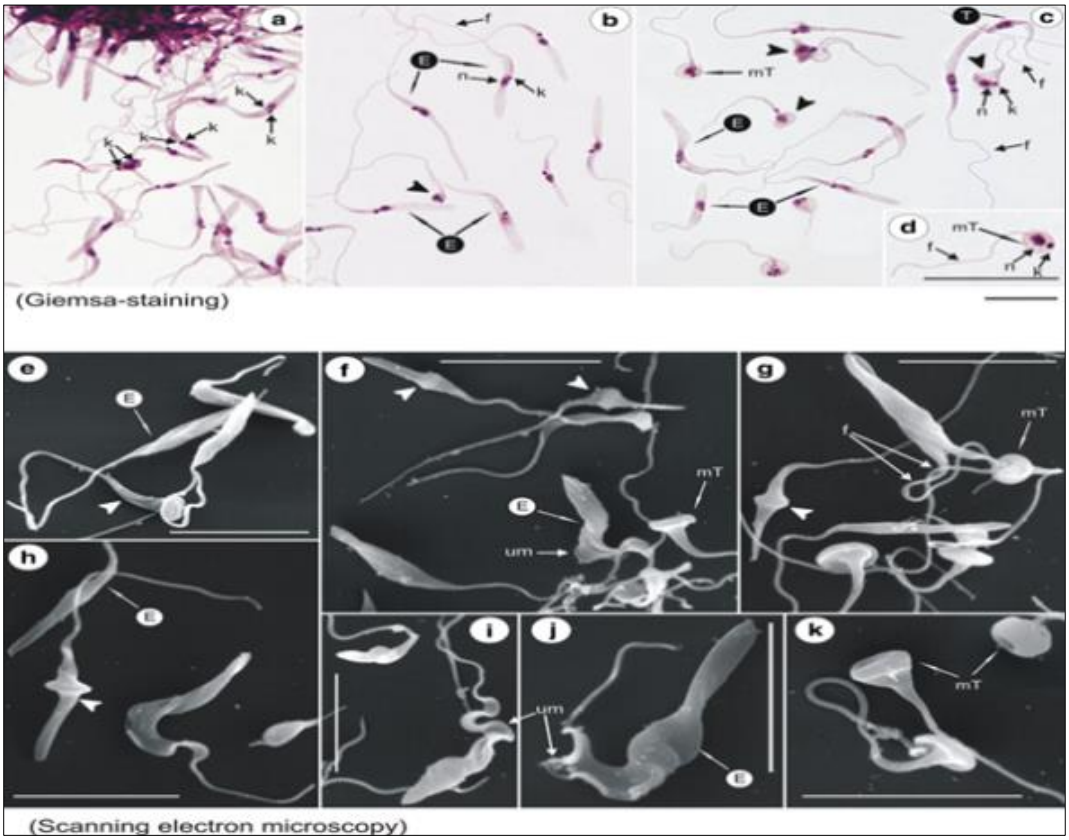
Figure 24 *Trypanosoma (Megatrypanum) melophagium* is a sheep parasite (*Lipoptena mazamae* Romdani, 1878 (Diptera, Hippoboscidae). Predicted life cycle of *Trypanosoma* (*Megatrypanum*) *trinaperronei* n. sp. in its host *Odocoileus virginianus* (white-tailed deer), and its putative vector the deer ked *Lipoptena mazamae* inferred from: early haemocultures showing long and slender trypomastigotes (a–c) and epimastigotes (d–g), both forms with noticeable undulant membrane; co-cultures with Hi-5 insect cells exhibiting clumps of small forms adhered to the insect cells (h, i) giving origin to rosettes of epimastigotes (j). Morphology and development of *T. trinaperronei* n. sp. co-cultivated with Hi-5 (25 °C) and $LLCMK_2$ mammalian (37 °C), from log- to stationary cultures, are detailed in the. Deer keds become infected by *T. trinaperronei* n. sp. feeding on deer containing blood trypomastigotes resembling those present in early haemocultures (a-c), which, in their digestive tract, transform and multiply as small forms attached to the cells of the gut wall, as observed in Hi-5 cells (h, i), give origin to rosettes of epimastigotes (j) that multiply and, later, differentiate into metacyclic trypomastigotes. Illustration of *T. trinaperronei* n. sp. metacyclogenesis in insect cultures are shown in the. Most likely, infective metacyclic trypomastigotes present in the feces of the vectors are transmitted to white-tailed deer by deer keds bite wound or mucosa, thus reaching the bloodstream and transforming into trypomastigotes resembling those detected in early haemocultures (a)

Table 1 Treatment of anogenital warts with SADBE: patient data

Patient No	Sex	Age (years)	Time of onset	Previous treatments	Site of warts	Clinical features	Area of application of SADBE	Number of applications
1	F	6	12 years	Multiple DTC	Perianal area	8 keratotic and flat-topped papules	dorsum of left hand	32
2	F	15	2 years	Multiple DTC	Perianal area	5 flat-topped papules	dorsum of left hand	38
3	M	20	10 months	Multiple DTC	Shaft	10 dome-shaped papules	shaft	36
4	M	24	17 months	Podophyllin resin Multiple DTC	Shaft	15 dome-shaped papules	shaft	34
5	F	25	6 months	Imiquimod 5% cream	Labia majora and minora, up to the vaginal introitus	2 warty plaques	pubic area	17
6	M	28	3 years	Podophyllin resin Multiple DTC	Coronal sulcus	1 warty plaque surrounding the coronal sulcus	pubic area	39
7	M	28	18 months	Podophyllin resin Multiple DTC	Shaft	12 dome-shaped papuls	shaft	–
8	M	29	9 months	Podophyllin resin Multiple DTC Surgical excision	Coronal sulcus	1 warty plaque surrounding the coronal sulcus	pubic area	37
9	M	70	16 months	Multiple DTC	Shaft	20 flat-topped, dome-shaped papules	shaft	32

Source: https://www.researchgate.net/figure/Treatment-of-anogenital-warts-with-SADBE-patient-data_tbl2_11204887

Examinations of stool specimens from other family members showed no larvae. Careful questioning about the child's dietary history revealed that she was fed over-ripened bananas, which were kept in a hanging wire basket in the kitchen. Flies were frequently observed on and around the fruit. No treatment was prescribed, but the parents were instructed to cover all fruit kept in the house and to wash it before consumption. By the end of September, the mother ceased to find larvae in the child's stool (Table 1) [23,24].



Source: https://parasitesandvectors.biomedcentral.com/articles/10.1186/s13071-020-04169-0

Figure 25 Light and scanning electron microscopy (SEM) of *Trypanosoma trinaperronei* n. sp. co-cultured with insect cells at 25 °C. Giemsa-stained (a–c) forms of a log-phase (5 days) culture (a) exhibiting flagellates adhered by their flagella forming rosettes, and detached epimastigotes. b Mid-log (7 days) cultures showing long and thin epimastigotes. c Stationary culture (10 days) exhibiting epimastigotes, transition forms between epi- and trypomastigotes (arrow heads), and unique bell-shaped metacyclic trypomastigotes. A typical metacyclic was enlarged in (d). SEM of mid-log cultures (7 days) showing epimastigotes of variable length and width (e–j) including forms with well-developed undulant membranes (f, j), transition forms (f–h), and bell-shaped metacyclic trypomastigotes (f, g, k). *Abbreviations*: nucleus, n; kinetoplast, k; flagellum, f; undulating membrane, um; epimastigote, E; trypomastigote, T; metacyclic trypomastigotes, mT. *Scale-bars*: a–k, 10 µm

4. Conclusion

This manuscript contributes to studies on the Hippoboscidae family, thus emphasizing the importance in this regard, especially the possible adaptive strategies, as they are still little known and can contribute to the understanding of host-parasite interactions.

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