



## Study of the characteristics of the Oestridae family (Muscoidea, Oestroidea)

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### Abstract

Oestridae is a family of flies, which includes species whose larvae are internal parasites of several species of mammals. Some species settle in the host's flesh, while others occur in the viscera. This study objective to report the characteristics of the Family Oestridae. 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, species, life cycle, damage, laboratory creation, economic importance, medicinal importance, biological aspects, monitoring and control and reproduction. A literature search was carried out containing articles published from 1950 to 2021. 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 and VADLO.

**Keywords:** Biology; Baites; Goiás; Medicinal importance; SciELO

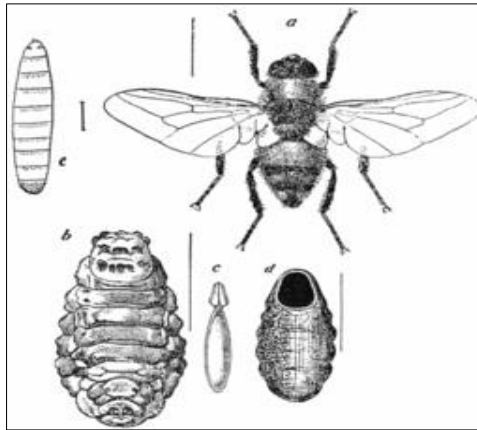
### 1. Introduction

Oestridae is a family of flies, which includes species whose larvae are internal parasites of several species of mammals. Some species settle in the host's flesh, while others occur in the viscera. The species *Dermatobia hominis* (Linnaeus Jr., 1781) is the only species in this group known to be a common parasite in humans, although other species can occur as occasional parasites, usually causing the condition known as myiasis or dermatobiosis. The flies of this family are generally known by the common names of the horn flies or blowflies, receiving multiple names depending on the region and the animal species they intestinal tract (Figures 1 and 2) [1,2,3,4].

The flies of the Oestridae family have life cycles that vary greatly depending on the species, but they are all in their larval stage, internal parasites of mammals. Larvae of some species settle in muscle tissue or under the skin of the host while others occur in the viscera, particularly along the intestinal tract. The Oestridae family, in turn, integrates the Oestroidea superfamily together with the Calliphoridae, Rhinophoridae, Sarcophagidae and Tachinidae families (Figure 3) [5].

Among the families of flies that cause myiasis (or dermatobiosis), Oestridae includes the largest proportion of species whose larvae are obligate parasites within the mammalian body. About 150 species of these parasites are known [5]. Most of the other species involved in myiasis are members of related families, such as Calliphoridae [6].

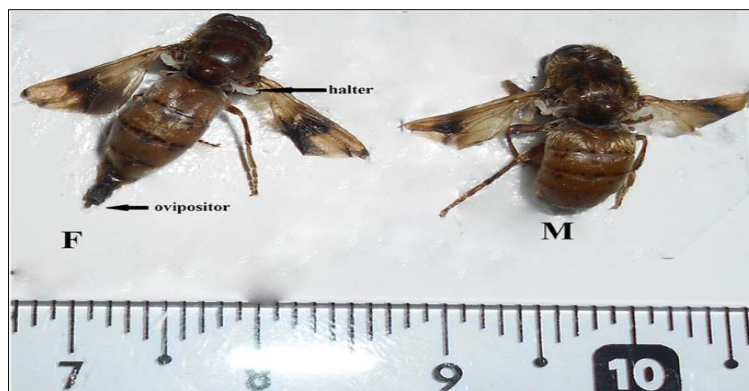
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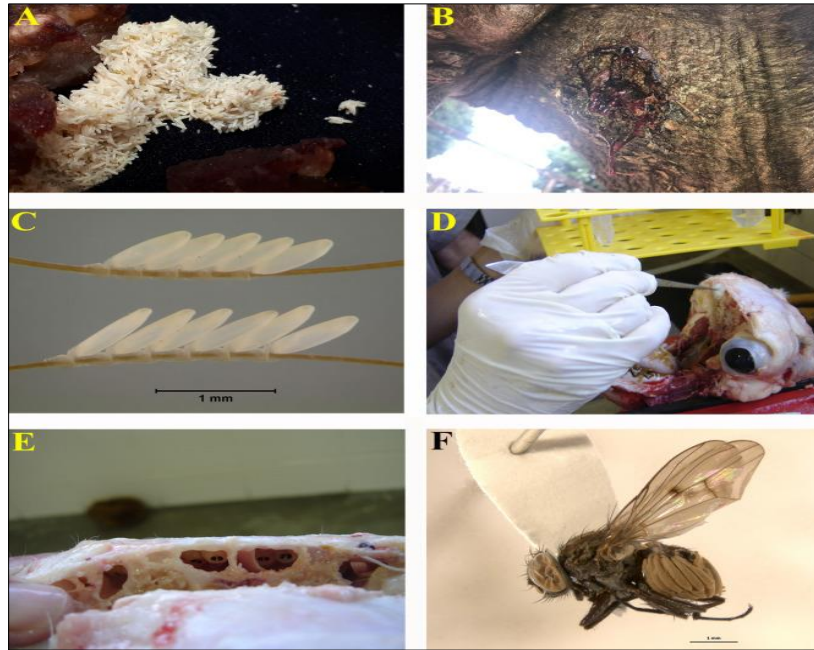
**Figure 1** a) Adult, b) pupae, c) egg, d) open pupa, e) larvae; (Source: [https://diptera.info/forum/viewthread.php?thread\\_id=34821](https://diptera.info/forum/viewthread.php?thread_id=34821))



**Figure 2** Oestridae adult; (Source: [https://diptera.info/forum/viewthread.php?thread\\_id=34821](https://diptera.info/forum/viewthread.php?thread_id=34821))



**Figure 3** Oestridae family (female and male); (Source: <https://link.springer.com/article/10.1007/s42690-019-00084-9>)



**Figure 4** Behavior and strategies of myiasis-causing flies to reach their hosts. (A) Blowflies females usually lay eggs, approximately 1 mm long each, grouped in masses to increase the offspring's chance of survival; (B) an example of an open wound on a cow's mammary gland: blood and injured tissue can attract flies to oviposition; (C) eggs laid at the base of the ox hair by *Hypoderma lineatum* (Villers, 1789); (D) and (E) *Oestrus ovis* larvae remain protected within the nasal sinus and sometimes in the tissues of their hosts' throat as they develop; (F) *Dermatobia* (already publishing previously)

### 1.1. Taxonomy

Class: Insecta, Order: Diptera, Superfamily: Oestroidea, Family: Oestridae, Subfamilies: Cuterebrinae, Gasterophilinae, Hypodermatinae and Oestrinae [7].

All subfamilies within Oestridae are related by their larval feeding characteristics. The larvae demonstrate obligatory myiasis because they require a living host to complete development. Completion of the bot flies' life cycle is dependent on the larvae consuming nutrients from tissues in the gastrointestinal tract of the horse.

#### 1.1.1. The Gasterophilinae are a subfamily of Oestridae which includes large, parasitic flies

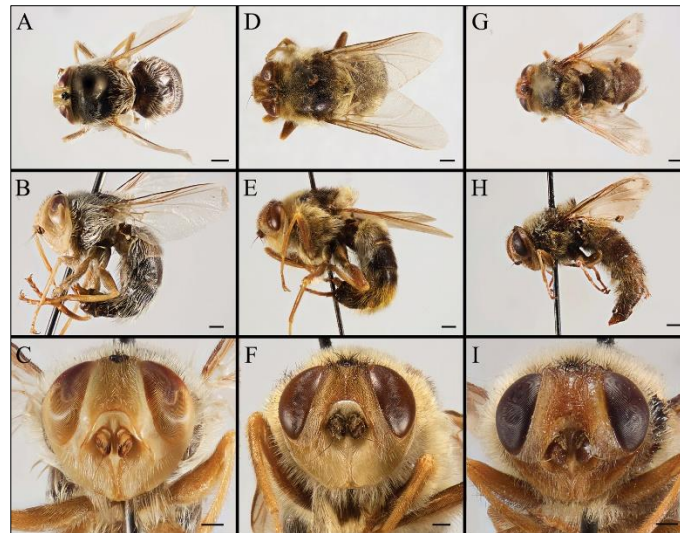
This group has historically been treated as a family, but all recent classifications place them firmly within the Oestridae. Many members of this subfamily spend part of their larval stages in the digestive tracts of herbivores. The best known genus is *Gasterophilus*, which attacks horses, deer, and similar animals. The genus *Cobboldia* breeds in elephants. The genus *Gyrostigma* breeds in rhinoceroses (Figure 5) [8].

Worldwide, nine different species of *Gasterophilus* exist, primarily affecting horses and donkeys. Three of the more common *Gasterophilus* species are found in North America. *Gasterophilus intestinalis* (DeGeer, 1776) is the more common horse bot fly, which is an internal parasite of the gastrointestinal tract. *Gasterophilus nasalis* (Linnaeus, 1758), the nose bot fly, and *Gasterophilus haemorrhoidalis* (Linnaeus, 1758), the throat bot fly, are also distributed throughout North America (Figures 5A and 5B [8].

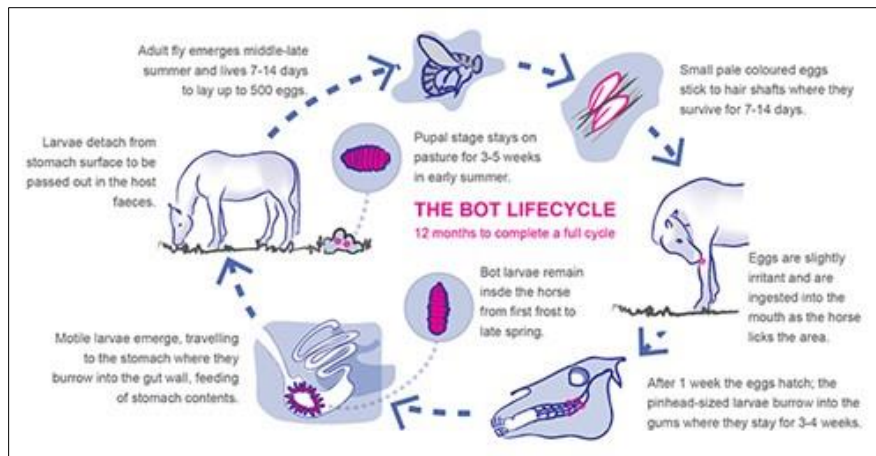
*Gasterophilus haemorrhoidalis* (also called nose botfly or lip botfly) is a species of the genus *Gasterophilus* that lays eggs on the lips and around the mouth of horses, mules, and donkeys. In Equidae, third-stage larvae attach to the stomach, but also to the rectum, sometimes in great numbers.

Source: Johannes Kaufmann, Parasitic Infections of Domestic Animals, Birkhäuser Verlag, Basel, Boston, Berlin, 1996. Heavy infestation can cause anal prolapse in foals and mules. They do not parasitize humans.

The Hypodermatinae are a subfamily of Oestridae. [1] The Hypodermatinae include large parasitic flies, some of which are known as warble flies. The 9 genera in this subfamily normally pass their larval stages in the skin or soft tissue of mammals, including cattle. These species include serious pests for livestock. Genus: *Hypoderma*, *Ochotonia*, *Oestroderma*, *Ostromea*, *Pallasiomyia*, *Pavlovskiata*, *Portschinskia*, *Przhevalskiana* and *Strobiloestro* (Figure 6) [9].



**Figure 5A** Dorsal view (A, D, G) and left lateral view (B, E, H) of habitus, and head in frontal view (C, F, I) of female *Gasterophilus* species, modified from Li et al. (2019) A–C *G. flavipes* (Olivier); China (in MBFU) D–F *G. haemorrhoidalis* (Linnaeus); China (in MBFU) G–I *G. inermis* (Brauer); Germany (in NHMD). Scale bars: 1 mm (A, B, D, E, G, H); 0.5mm (C, F, I); (Source: <https://zookeys.pensoft.net/article/38560/zoom/fig/17/>)

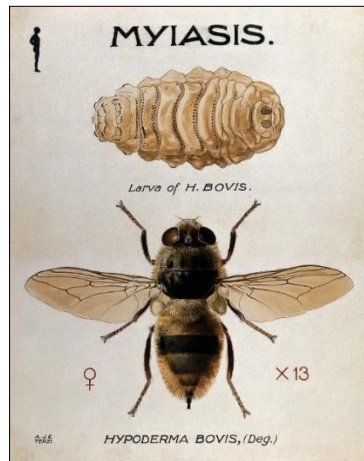


**Figure 5B** life cycle *Gasterophilus haemorrhoidalis* L. 1758. Adult bot flies are medium to large brown striped insects, 10-20mm long, a bit like a scrawny wasp or drone bee with a single pair of wings. Once hatched the adult flies survive long enough to mate and lay their eggs on the horse, dying once nutrients remaining from their larval stage are used, usually in around 2 weeks; (Source: <http://www.icb.usp.br/~marcelcp/Gasterophilus.htm>)

Oestrinae is a subfamily of Oestridae that includes parasite flies attacking a variety of different hosts. There are 9 genera with 34 species in this subfamily, which normally pass their larval stage in the skin or soft tissue of mammals, including deer or sheep (such species are often considered pests). Adult flies give birth to a live larva in the host's nostril (Figure 7) [10,11,12,13,14].

*Gasterophilus intestinalis* (DeGeer, 1776), also known as flying bot horse, is a species of insect in the Oestridae family, and is found all over the world. Adults, which have a bee-like appearance, are prominently active in summer. *G.*

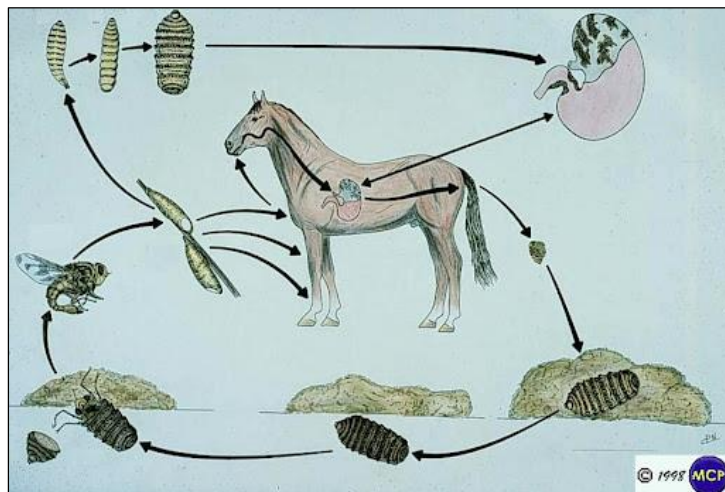
*intestinalis* is primarily a parasite of horses, mules, and donkeys. The eggs of *G. intestinalis* are pale yellow in color, and 1-2 mm (0.039-0.079 in.) in length. Larvae are yellow or brown (Figure 8, 9,10, 11, 12, 13, 14,15 and 16).



**Figure 6** Hypodermatinae; (Source: <https://inaturalist-open-data.s3.amazonaws.com/photos/12831691/original.jpg?1545925486><https://inaturalist-open->)



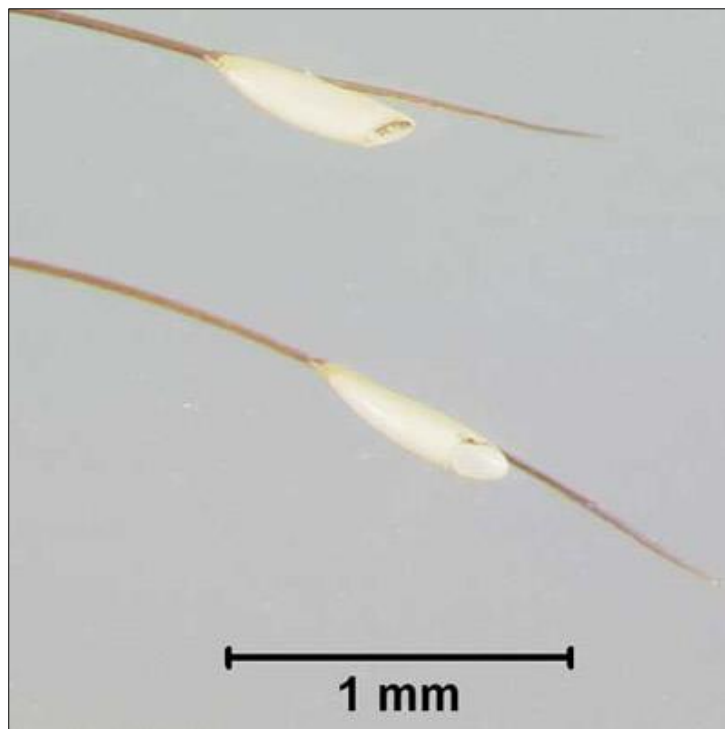
**Figure 7** Oestrinae Subfamily; (Source: <https://inaturalist.ca/taxa/349398-Oestrinae>)



**Figure 8** Life cycle of the equine stomach bot *Gasterophilus intestinalis* (DeGeer, 1776) The larvae of *Gasterophilus* sp are parasites of equines and are known as bots. The *Gasterophilus* larvae become parasitic when licked by the host, thus the infestation starts in the mouth. The larvae eventually migrate to the stomach where they attach to the inner lining with their bodies exposed to the stomach cavity. When mature they exit in the feces, then pupate. Adult flies live for a few days whilst mating and laying eggs; (Source: <http://www.icb.usp.br/~marcelcp/Gasterophilus.htm>)



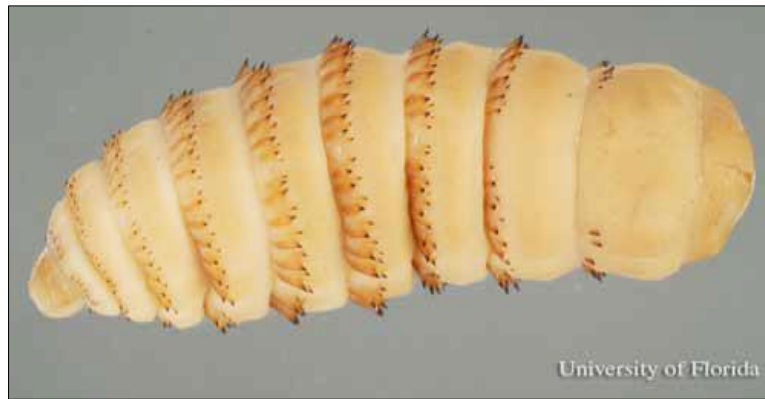
**Figure 9** Horse bot fly, *Gasterophilus intestinalis* (DeGeer, 1776), egg case (hatched) attached to a horsehair. Source: Photograph by Morgan McLendon, University of Florida



**Figure 10** Horse bot fly, *Gasterophilus intestinalis* (DeGeer, 1776), egg casings (hatched) attached near the tip of horsehairs; (Source: Photograph by Morgan McLendon, University of Florida)



**Figure 11** Horse bot fly, *Gasterophilus intestinalis* (DeGeer, 1776), larval infestation in the stomach of a horse; (Source: Photograph by Jerry Butler, University of Florida)



**Figure 12** Dorsal view (head on left) of the third instar larva of the common horse bot fly, *Gasterophilus intestinalis* (DeGeer, 1776); (Source: Photograph by Lyle Buss, University of Florida)



**Figure 13** Ventral view (head on left) of the third instar larva of the common horse bot fly, *Gasterophilus intestinalis* (DeGeer, 1776); (Source: Photograph by Lyle Buss, University of Florida)



**Figure 14** Pupa of the common horse bot fly, *Gasterophilus intestinalis* (DeGeer, 1776); (Source: Photograph by Lyle Buss, University of Florida)



**Figure 15** Lateral view of the adult common horse bot fly, *Gasterophilus intestinalis* (DeGeer, 1776); (Source: Photograph by Lyle Buss, University of Florida)



**Figure 16** First stage larva of a horse bot fly, *Gasterophilus* sp., in a human eye; (Source: Photograph by Jerry Butler)

Pupae After the third instar larvae have matured, they detach from the gastrointestinal tract and pass from the horse's body in the feces. The larvae burrow into the soil or dried manure where they pupate and remain for the next one to two months. This stage of the life cycle occurs between late winter and early spring. Because of horses' behavior to



habitually defecate in the same location and the lack of larvae movement, the number of pupae in fecal piles can become rather significant. Adults, which are 10-15 mm (0.39-0.59 in.) in length, appear superficially furry bees, with a noticeable ovipositor at the end of the abdomen. Clinical signs are uncommon in host animals [15,16,17,18,19].

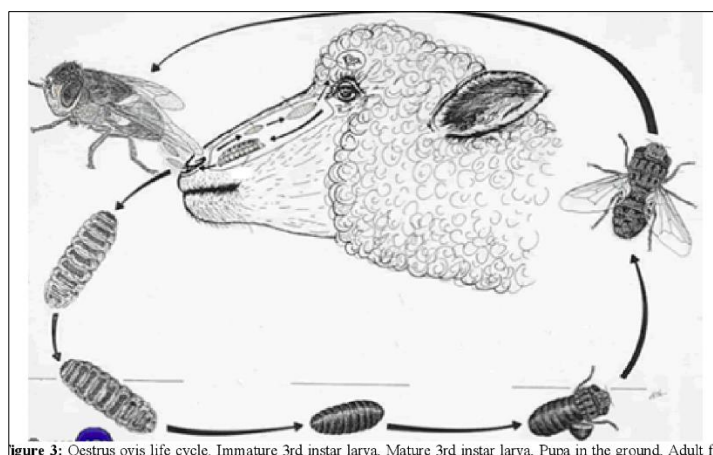
Large numbers of larvae in the stomach can cause stomach pain, and, rarely, extremely large infestations can cause an obstruction in the flow from the stomach to the duodenum. Larvae are usually found moreover when the host's stomach is examined by endoscope. Often, the only sign of infestation is finding larvae in the stool. The main impact on the host is annoyance for adults, as they repeatedly land on their legs when trying to lay eggs [18,19].

The common host of this species of bot fly is the horse. Other equid species, including mules and donkeys, can also serve as hosts. Although accidental, the horse bot also has been reported in man causing either ocular (eye) or cutaneous (skin) myiasis (Figure 17) [18,19].



**Figure 17** Cutaneous (skin) myiasis; (Source: [https://www.jaad.org/article/S0190-9622\(08\)00302-2/references](https://www.jaad.org/article/S0190-9622(08)00302-2/references))

The horse bot fly occasionally can cause what is called ocular myiasis, or invasion of the eye by first stage larvae. Although these cases are rare, they often occur in individuals handling horses that have bot fly eggs on their hair. Occasionally, these bot fly larvae will enter the eye, rather than reside on the surface as is more common with the sheep nose bot, *Oestrus ovis* Linnaeus 1758 (Figure 18) [20].

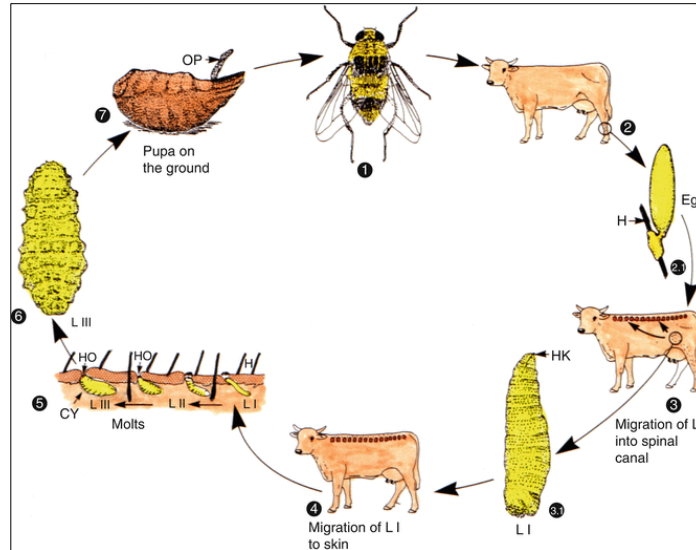


**Figure 3:** *Oestrus ovis* life cycle. Immature 3rd instar larva, Mature 3rd instar larva, Pupa in the ground, Adult fly

**Figure 18** *Oestrus ovis* Linnaeus 1758 Life cycle. Immature 3rd instar larva, Mature 3rd instar larva, Pupa in the ground, adult fly emerges from the pupa and Mature fly respectively in anticlockwise direction; (Source: (Widad, 2010))

An additional rare form of horse bot myiasis is called cutaneous myiasis. In this case, hatching larvae enter the skin of humans and begin burrowing through the skin causing visible, sinuous, inflamed tracks accompanied by considerable

irritation and itching. Anyone working with horses during bot fly season should be familiar with the risks and take appropriate precautions (do not rub eyes after combing or washing animals and wash hands when finished) (Figure 19) [20].



**Figure 19** Myiasis, Animals (Source: (Widad, 2010))

### Objective

This study objective to report the characteristics of the Family Oestridae.

## 2. Method

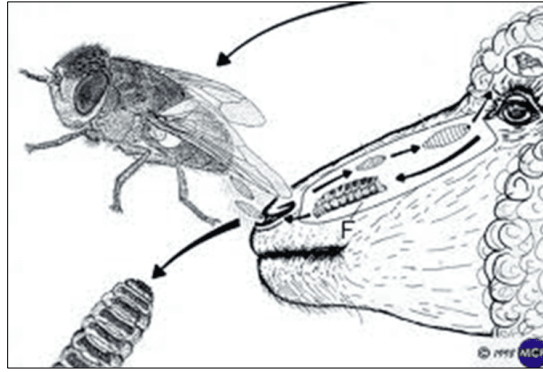
The research was carried out in studies related to quantitative aspects of the Family, Subfamily and Species (taxonomic groups) and conceptual aspects such as: biology, ecology, geographical distribution, methodologies, and traps for collecting and their and strategies for Oestridae with control, species, life cycle, damage, laboratory creation, medical and veterinary importance, economic importance, biological aspects, and reproduction. A literature search was carried out containing articles published from 1950 to 2021. 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 and VADLO.

## 3. Studies

### 3.1. Study1

The purpose of this manuscript is to review the available literature on oestrosis in sheep and goats and its economic and zoonotic importance.

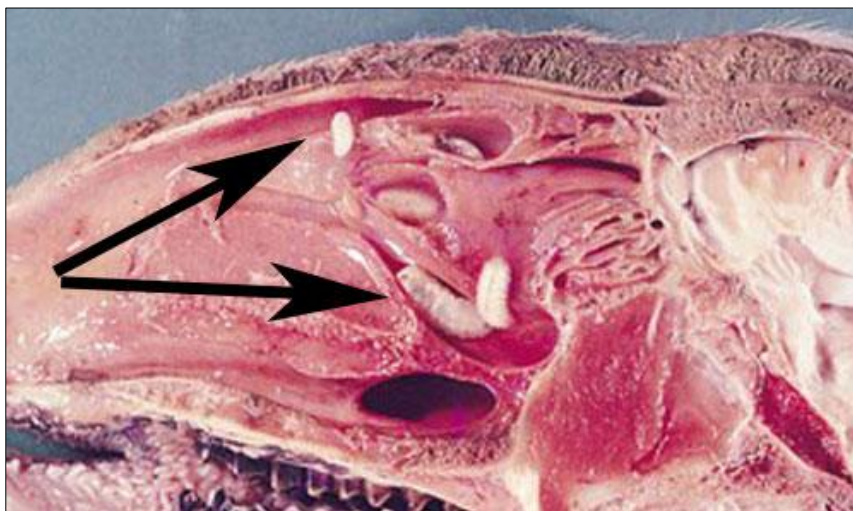
Oestrosis is a form of myiasis caused by larvae of the *Oestrus ovis* Linnaeus 1758. It is known for its parasitic predation and damage to sheep, deer, goats, camels, dogs, and humans. *Oestrus ovis* larvae usually inhabit the nasal cavities and sinuses of sheep and goats and subsequently cause myiasis. This myiasis severely impairs the health status, causes difficult breathing, mouth breathing, emaciation, weight loss and sometimes larvae can migrate to the brain causing false gid (Figures 20, 21, 22, 23, 24, 25 and 26).



**Figure 20** life cycle of *Oestrus ovis* Linnaeus, 1758; (Source: <https://www.semanticscholar.org/paper/On-Oestrosis-On-Sheep-And-Goat-Dawud/527f173db100e3ca45cd465643065ed8fb000de5>)



**Figure 21** *Oestrus ovis* Linnaeus 1758; (Source: [https://entnemdept.ufl.edu/creatures/LIVESTOCK/sheep\\_bot\\_fly.html](https://entnemdept.ufl.edu/creatures/LIVESTOCK/sheep_bot_fly.html))



**Figure 22** A cross section of a sheep's nasal cavity, exhibiting larvae of *Oestrus ovis* L. 1758 found within (arrows)  
Source: Photograph by Jack Lloyd, University of Wyoming

*Oestrus ovis* is an economically important parasite of nasal cavities in sheep and goats worldwide. The adult fly is grayish brown and approximately 12 mm long. The female deposits larvae in and around the nostrils of ewes. These small, pale

larvae (initially <2 mm long) enter the nasal cavity and develop. When mature, the larvae leave the nasal passages, fall to the ground, bury themselves a few centimeters and become pupae. The pupal period lasts from 3 to 9 weeks, depending on environmental conditions, after which the fly emerges from the pupal box and pushes its way to the surface. Mating soon occurs and the female begins to deposit larvae [20].



**Figure 23** Late stage just prior to molting L3 (1.18 inches (30 mm) in length) of *Oestrus ovis* L. with spines visible along the back of the larva (arrow); (Source: Photograph by Lyle J. Buss, University of Florida)



**Figure 24** Size comparison of *Oestrus ovis* L. larval instars, from top to bottom: L3 (up to 30 mm long), L2 (3 to 14 mm long), and L1 (1 mm long); (Source: Photograph by Lyle J. Buss, University of Florida)



**Figure 25** Wing of an adult *Oestrus ovis* L., 1758; (Source: Photograph by Lyle J. Buss, University of Florida)



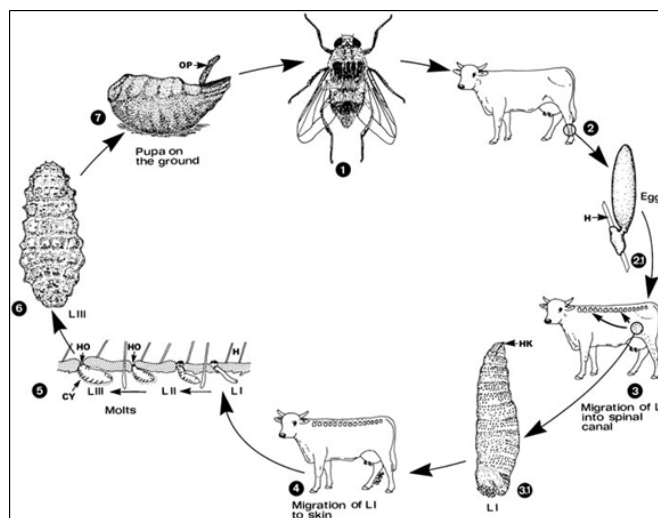
**Figure 26** *Oestrus ovis* L. infestation of a sheep resulting in nasal discharge symptom; (Source: Photograph by Jack Lloyd, University of Wyoming)

### 3.2. Study 2

The aim of this study is to describe the characteristics of *Hypoderma lineatum* Villers, 1789 and *Hypoderma ovis* L., 1758.



**Figure 27** *Hypoderma ovis* L., 1758; (Source: <https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/hypoderma-bovis>)



**Figure 28** *Hypoderma ovis* L., 1758 life cycle; (Source: [https://link.springer.com/referenceworkentry/10.1007%2F978-3-540-48996-2\\_1553](https://link.springer.com/referenceworkentry/10.1007%2F978-3-540-48996-2_1553))

The warble, or both, flies *H. lineatum* and *H. ovis* are large, heavy, and beelike. The females deposit their eggs on the legs of cattle. The larvae penetrate the skin, migrate through the body for several months, and produce a characteristic lump, or warble, on the animal's back. The warble contains a hole, which is used for breathing. When fully developed, the cattle grub emerges and drops to the ground to pupate and transform into an adult fly. The breathing holes cut by the larvae in the cowhide reduce its commercial value. *Hypoderma (Oedemagena) tarandi* L. 1758 is another warble fly that causes economic losses of leather, meat, and milk in reindeer herds (Figures 27, 28 and 29) [21].



**Figure 29** larva of *Hypoderma ovis* L., 1758; (Source: [https://entnemdept.ufl.edu/creatures/livestock/cattle\\_grub.htm](https://entnemdept.ufl.edu/creatures/livestock/cattle_grub.htm))



**Figure 30** Eggs of heel fly, *Hypoderma bovis* L., 1758 (Oestridae, Hypodermatinae), attached to body hair of cow; (Source: Courtesy of Agriculture and Agri-Food Canada, Lethbridge)



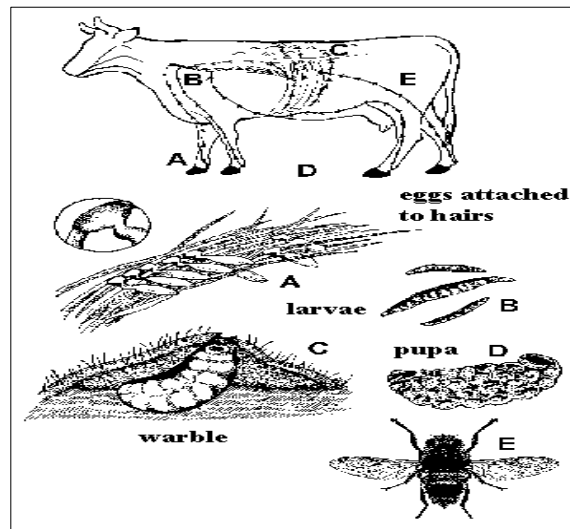
**Figure 31** Multiple warbles along back of cow, caused by *Hypoderma bovis* (Oestridae, Hypodermatinae); (Source: Photo by J. Weintraub, Agriculture and Agri-Food Canada, Lethbridge)

The warble fly is widespread in Europe and North America. Control methods in cattle include the oral administration of insecticides and manual removal of the larvae from the animals' backs. In the warble flies (*H. lineatum* and *H. bovis*; subfamily Hypodermatinae), young larvae penetrate the skin of cattle and migrate through the body for several months until they come to rest beneath the skin of the animal's back. There each larva causes a characteristic lump, or warble, from which a cattle grub emerges. The grub becomes a pupa and then a fly to deposit more larvae (Figures 30 and 31) [21].

### 3.3. Study 3

The objective of this work is to describe the life cycle of *Hypoderma*

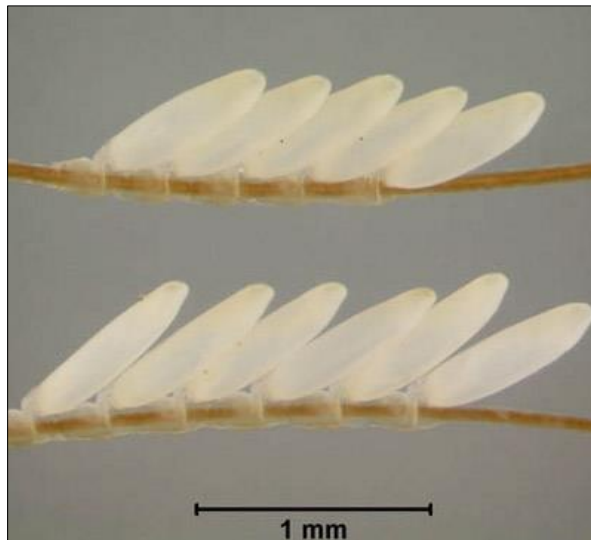
Adult *Hypoderma*, known also as heel flies or gad flies, are 15 mm long, hairy, and bee-like in appearance. In late spring or early summer, they attach their eggs on the hair of cattle, particularly on the legs and lower body regions. The eggs hatch in 3–7 days, and first-stage larvae travel to the base of the hair shaft and penetrate the skin. Normally, the first-stage larvae travel through the fascial planes between muscles, along connective tissue, or along nerve pathways. They secrete proteolytic enzymes that facilitate their movement. During fall and winter, larvae migrate toward two different regions, depending on the species. *Hypoderma lineatum* Villers, 1789 larvae migrate to the submucosal connective tissue of the esophageal wall, where they accumulate for 2–4 mo. *Hypoderma ovis* L., 1758, larvae migrate to the region of the spinal canal, where they are found in the epidural fat between the dura mater and the periosteum for a similar period.



**Figure 32** Life cycle of a cattle grub; (Source: Photograph by Lyle J. Buss, University of Florida)



**Figure 33** Pinned adult male common cattle grub, *Hypoderma lineatum* (Villers, 1789); (Source: Photograph by Lyle J. Buss, University of Florida)



**Figure 34** Eggs of the common cattle grub, *Hypoderma lineatum* (Villers, 1789), on cattle hairs; (Source: Photograph by Lyle J. Buss, University of Florida)



**Figure 35** Larva of the common cattle grub, *Hypoderma lineatum* (Villers, 1789), dorsal view. The head is to the left; (Source: Photograph by Lyle J. Buss, University of Florida)

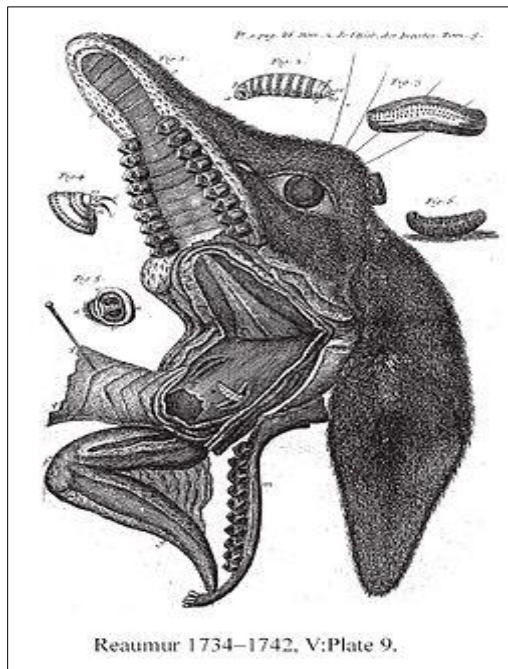


**Figure 36** Larva of the common cattle grub, *Hypoderma lineatum* (Villers, 1789), ventral view. The head is to the left; (Source: Photograph by Lyle J. Buss, University of Florida)





**Figure 37** Pinned adult (top) and pupal case (bottom) of the common cattle grub, *Hypoderma lineatum* (Villers, 1789); (Source: Photograph by Lyle J. Buss, University of Florida)



**Figure 38** Dissected head of a deer showing Oestrinae larvae; (Source: <https://pt.wikipedia.org/wiki/Oestrinae#/media/Ficheiro:DeerBotFlyReaumur.jpg>)

Beginning in early winter, the larvae arrive in the subdermal tissue of the back of the host, where they make breathing holes (central punctum) through the skin. Cysts or warbles form around the larvae, which undergo two molts (second and third stage). The warble stage lasts 4–8 wk. Finally, third-stage larvae emerge through the breathing holes, drop to the ground, and pupate. Flies emerge from the pupae in 1–3 mo, depending on weather conditions. Adult flies, which do not feed, live <1 wk. The life cycle is complete in 1 yr. (Figures 32, 33, 34, 35, 36, 37 and 38) [22].

#### 4. Conclusion

The Oestrinae includes flies which larvae cause only obligatory myiases. Oestrinae contains many species, about 150, whose larvae parasitize a wide range of hosts, from mice to elephants. They display a high degree of host specificity, and their biological life cycle may be extremely complex as a result of a long lasting adaptation to the host. The four sub-families of medical and veterinary importance are Gasterophilinae, Oestrinae, Hypodermatinae and Cuterebrinae.

Within the Gasterophilinae, the most important genus, *Gasterophilus*, consists of eight species, three of which are worldwide distributed.

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