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RAISING AWARENESS OF MYIASIS: A CASE SERIES FROM AUTOCHTHONOUS AND IMPORTED INFESTATIONS

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Abstract

Myiasis is an infestation of the tissues of livinghumans and other vertebrates by the immature stages (larvae) of Diptera. According to the International Classification of Diseases, myiasis belongs to the morbidity classification ICD-10-CM, with the ICD code B87 (2025 edition).

Myiasis is not mandatory to report, and through our experience, we aimed to raise awareness of this infestation among medical practitioners and the public. We discuss seven cases of myiasis diagnosed over five years (2019-2024) whose specimens (larvae) was submitted to the Institute for Microbiology and Parasitology, Medical Faculty - Ss. Cyril and Methodius University in Skopje, Republic of North Macedonia.

The collected maggots were analyzed through macroscopic and microscopic examination. Morphological identification of the larvae was conducted using identification keys.

Photographs were taken using an Olympus SZX9 and a Carl Zeiss Stemi 508 stereo microscope with an integrated high-resolution digital camera. Our findings confirmed an infestation by larvae from two autochthonous species, *Sarcophaga argyrostoma* and *Lucilia sericata*. We also identified an imported fly species, *Cordylobia anthropophaga*.

The larvae can cause various symptoms depending on their relationship with the host and the anatomical location in the body.

The outcome is related to comorbidities and the provision of appropriate, timely treatment. Medical practitioners should consider myiasis in their differential diagnosis. Nosocomial myiasis is a significant concern and requires special attention and preventive measures.

Keywords: myiasis, *Sarcophaga argyrostoma*, *Lucilia sericata*, *Cordylobia anthropophaga*, Republic of North Macedonia

Introduction

Myiasis is the infestation of tissues of humans and other vertebrates by Diptera larvae, a large order of true flies [1,2]. Flies are usually associated with vector-borne diseases in humans (viral, protozoan, and helminthic), but their immature stages, soft-bodied, legless larvae *(often called* maggots), can cause myiasis.

The name originates from the Greek word ‘myia’, meaning fly, and was introduced by Hope for the first time in 1840 [3,4]. Later, the term myiasis was defined as “The infestation of live human and vertebrate animals with dipterous larvae, which, at least/or for a certain period, feed on the hosts dead or living tissue, liquid body-substances, or ingested food” [5].

There are several classifications based on the anatomical side or biological characteristics of flies. According to the International Classification of Diseases, Myiasis belongs to morbidity classification ICD-10-CM, ICD code B87 (2025 edition).

Further, based on anatomical parts of infestation, clinical cases of myiasis are subdivided to Cutaneous myiasis (wound, furuncular, migratory), Myiasis of external orifices (Ocular myiasis, Nasopharyngeal myiasis, Aural myiasis), Myiasis of other sites such as Genitourinary myiasis and Intestinal myiasis, as well as unspecified Myiasis [6].

There is classification of myiasis according to the flies that cause it [7, 8].

Maggots must feed on host tissue (living or dead), body liquids, or ingested food as part of the flies' life cycle.

According to that relationship, myiasis can be divided into obligatory / primary:caused byobligatory parasitic flies, whose larval stages can occur only in the living tissue of animal or human hosts.

They need living tissue to complete their life cycle. Free-living flies cause facultative/secondary myiasis. Usually, their maggots preferentially feed on carrion and decaying matter. Those flies cause opportunistic infestation of pre-existing wounds of living human and animal hosts. Wounds often contain dead or necrotic tissue.

All obligatory and most facultative myiasis species are classified in the Muscoidea, Oestroides, Calliphoridae, and Sarcophagidae families [7].

The third type is accidental / pseudomyiasiscaused by the infestation of mucous membranes or biofilms on medical devices, leading to genitourinary myiasis and intestinal myiasis due to accidentally ingested maggots [9].

According to the time of onset, myiasis can be divided into community-acquired infection (CAI) or nosocomial infection (NI).

Myiasis is spread worldwide in animals and humans, but underlying data on its prevalence are narrow [10]. Compared to animal myiasis, infestation in humans is infrequent. About 165 cases of human myiasis were reported from 1914 to 2014 [10]. Furthermore, in the medical literature of the past two decades (2000–2020), 52 articles reported cutaneous myiasis in 65 patients living in Europe [11].

The risk factors that increase the disease incidence are poor hygiene, patients with mental disorders without care, drug addicts, cancer, advanced age, diabetes, homelessness, immobility, and unconsciousness.

The disease is associated with socio-economically poor regions, rural background, certain cultural habits, trips to tropic regions, and favorable weather conditions for flies [10].

The geographic distribution of individual fly species varies. Contrary to other insect species, flies are predicted to increase in a global warming scenario (Warming Climate Implies More Flies—and Disease, Feb. 20, 2019, www. Scientific american.com).

Consequently, the incidence of myiasis in non-endemic regions such as Europe could rise due to climate change's effects and the migration of fly species from tropical and subtropical countries [11].

The larvae can cause a broad range of symptoms depending on the relationship of the larvae to the host and the anatomical location of the body. Curative and preventive measures rely on the type of myiasis, causative agent species, and host immunocompetence.

The first clinical cases of myiasis in different warm-blooded vertebrates, including humans in Republic of North Macedonia were reported in 1925 and 1926. Namely, two cases of human myiasis caused by flesh fly *Wohlfahrtia magnifica* (Schiner, 1862) (Diptera: Sarcophagidae), were described at the Clinic for Skin and Venereal Diseases of the State Hospital in Skopje, Republic of North Macedonia [12].

Recently, 4 cases of ophthalmomiasis were diagnosed and treated in the country at the Shtip Clinical Hospital [13].

It is characteristic that all the patients are men who are engaged in animal husbandry and agriculture and they are from a rural environment.

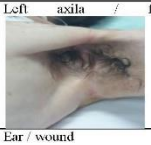
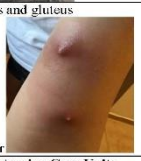
This review is a six-year retrospective study (2019 - 2024), addressing the types of myiasis and the fly larvae that cause it. All patients were from Skopje and larvae were submitted to the Department of Microbiology and Parasitology, Faculty of Medicine in Skopje.

Myiasis is not mandatory to report, and through our experience, we aimed to raise awareness of this infestation among the medical practitioners and the public.

Material and methods

The material was obtained from patients with different types of myiasisover six years (2019 to 2024). A retrospective study included seven patients with aural, nasal, and cutaneous myiasis (Table 1).

Table 1: Summary of different lesions in patients who submitted specimens (larvae) to the Institute for Microbiology and Parasitology, Faculty of Medical "Ss. Cyril and Methodius" University in Skopje, Republic of North Macedonia

Year/ Sex/ Age	Location / Type of lesion	Fly species	Comorbidities/Risk factors
Case 1 2019/ male/ 44 years	Left axila / furuncule 	6 maggots 	Comatose/ ICU / post neoplasm surgery [19]
Case 2 2021/ Female/ 74 years	Ear / wound		skin-carcinoma of the outer ear - auricular convalescent
Case 3 2022/ Female/ 35 years	Nose	4 live maggots video Unidentified 	Post COVID-19 [19]
Case 4 2023/ Female/ 74 years	Forehead fistula / artificial hole 	10 live maggots 	Forehead fistula with purulent discharge
Case 5 2024/ Family cluster/ Female/ 12, 35 and 58 years	Extremities and gluteus  /furuncular	 One from each lesion	Trip to Tanzania-Zanzibar [18]
Abbreviations: ICU - Intensive Care Units			

Collecting and processing specimens

Maggots were collected by patients or medical staff at healthcare facilities. The specimens submitted to the Institute for Microbiology and Parasitology were preserved in 70% ethanol [14]. Subsequently, they were analyzed through macroscopic and microscopic examination.

Photographs were taken with an Olympus SZX9 and Carl Zeiss Stemi 508 stereo microscope equipped with an integrated high-resolution digital camera. The length of each larva was measured under a binocular microscope in 0.1 mm units using a vernier caliper.

Morphological identification to species level

Further identification at the species level was performed in collaboration with parasitologists from the Faculty of Veterinary Medicine, "Ss. Cyril and Methodius" University in Skopje, Republic of North Macedonia and forensic entomologists from the Faculty of Natural Sciences and Mathematics, "Ss. Cyril and Methodius" University in Skopje, Republic of North Macedonia.

Preparation of material for microscopic examination. To facilitate identifying the larvae and visualizing the morphological details of the cephalopharyngeal skeleton and integument, the clearing technique proposed by Niedereggeret all. was applied. [15]

The morphological identification of the larval specimens was performed using the identification keys provided by Szpila et all. and Zampt (1965). [16,17, 5].

Results

Results are based on several aspects: macroscopic and microscopic analysis, which includes body shape, features of the papillae, the posterior spiracles (including position, shape, openings, and structures), pigmentation of the dorsal tracheal trunks, the body surface (spines), the anterior spiracles, the cephalopharyngeal skeleton, and the clinical behavior of maggots based on anamnesis. This analysis confirmed the species of fly and the type of myiasis (Table 2)

Table 2. Summary of myiasis type and causing larvae species

Table 2 Summary of myiasis type and causing larvae species			
Case	Type of myiasis	Fly species	Prognosis/follow up
Case 1	Secundary cutaneus myiasis HAI	*Sarcophaga argyrostoma (*Autochthonous*)* *Family (Sarcophagidae)* *genera, Sarcophaga* **Figure 1**	Infaust / pass away
Case 2	Aural secundary myiasis CAI	*Lucilia sericata* (Autochthonous) *Family Calliphoridae* Genera Lucilia **Figure 2**	Infaust / pass away
Case 3	Nasal / Cavitary myiasis CAI	Unidentified Autochthonous	Excellent / recovery
Case 4	Secondary wound / cavitary myiasis CAI	*Sarcophaga argyrostoma* (Autochthonous) **Figure1**	Good / recovery
Case 5 Family cluster (three patients)	Primary furuncular, CAI	*Cordylobia anthropophaga (*Imported species) *Family Calliphoridae* genera *Calliphora* **Figure3**	Excellent / recovery
Abbreviations: HAI - Hospital acquired infection; CAI - community acquired infection			

The larvae specimens extirpated from the comatose patient in the ICU (Case 1) and from patient with a forehead fistula (cutaneous myiasis) in Case 4, were identified as second instar larvae (6-8mm) of *Sarcophaga argyrostoma* (Sarcophagidae) (Figure 1).

Figure 1. a) larvae before and b) after the clearing technique. c) anterior view (mouth hooks) C anterior spiracle d) posterior view D) posterior spiracle e) cephaloskeleton

Maggots collected from **auricular myiasis (Case 2)** were identified as *Lucilia sericata* (Figure 2).

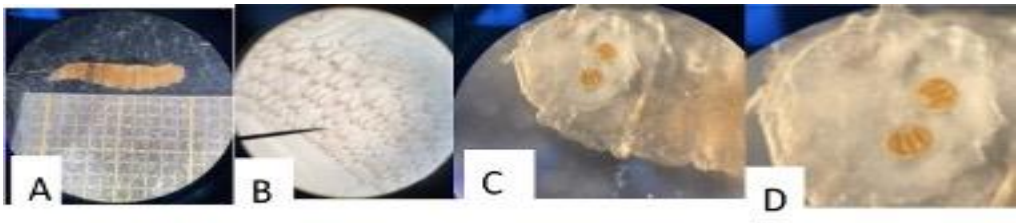


Figure 2. A) Larvae of *Lucilia sericata (Meigen)* B) small spines on thoracic segments without serrated tips C) caudal view, D) posterior spiracle

Maggots extirpated from furuncles of three patients traveling in Zanzibar (**Case 5)**, were identified as *Cordylobia anthropophaga* (family *Calliphoridae*) Figure 3.

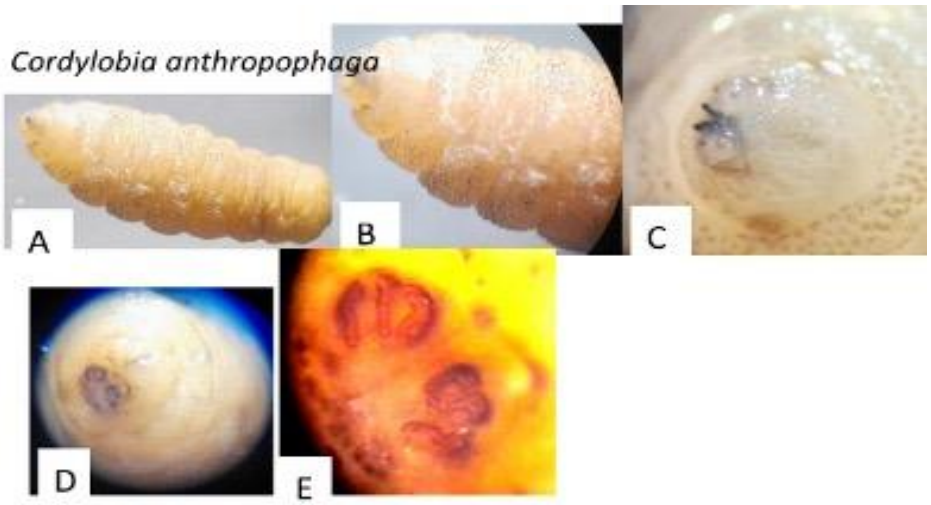


Figure 3. A) 7×2.7 mm in size, segmented, cylindrical, yellowish body with B) multiple brown cuticular spines. C) Anterior end of *C. anthropophaga* showing two black mouth-hooks. D) Posterior view, E) posterior spiracle of the larvae, with three curved openings

All larval specimens are stored in the Macedonian National Collection of Invertebrates at the Faculty of Natural Sciences and Mathematics, "Ss. Cyril and Methodius" University in Skopje, Republic of North Macedonia.

Discusion

There are three families involved in the development of myiasis in vertebrates: Oestridae, Calliphoridae with four genera Calliphora, Lucilia, Chrysomyia and Cochliomyia and Sarcophagidae with two genera, Sarcophaga and Wohlfahartia as agents of myiasis [2].

Which species will infestate the host depends on geographic region, life cycle of flies, and host risk factors.

At the Institute of Microbiology and Parasitology, we have identified seven cases of myiasis and three different causative agents for six years (2019 -2024).

Four of them were secondary myiasis caused by autochthonous species (*Sarcophaga argyrostoma* and *Lucilia sericata*) and three were primary myiasis in travelers caused by *Cordylobia anthropophaga*, the imported species from Tanzania-Zanzibar [18].

Sarcophaga argyrostoma caused nosocomial myiasis (NAI) in a44-year-old terminally ill patient [19]. Briefly, the patient had infratentorial brain neoplasm and underwent surgery intervention. When myiasis was diagnosed, he was unconscious and on mechanical ventilation for four months (March- June 2019).

Although isolated in a separate part of the hospital ward, six maggots (ivory-colored, 6-8mm long) were found in his left axilla. *Sarcophaga argyrostoma* is a flesh fly and belongs in the "nosocomial myiasis agents" category. In Europe, *Sarcophaga spp*. is most frequently collected as larva on human corpses [17,20].

The flies also lay in garbage and decaying organic matter, such as necrotic tissueIt can occur anywhere, particularly when contributing factors such as unconsciousness, odours, necrotic tissue and puss are present.

Flesh flies are attracted by the smell of fresh or infected and untreated wounds and lay eggs (or larvae, as in the case of *Sarcophaga*). Consequently, the most frequent facultative myiasis is cutaneous type with two clinical manifestations: furuncular and wound myiasis [7, 21-23] Our result corresponds to literature data.

Although Nosocomial myiasis is generally considered to be rare, it occurs worldwide in ICUs, either in highly urbanized areas or in countries with low standards of living [23,24].

The first report on nosocomial myiasis was in 1980 [25].

Correct identification of the myiasis agent is crucial to recognizing the need for urgent preventive measures in healthcare facilities. Authorities should pay attention to its timely detection, especially in vulnerable populations in ICUs during the summer period. In this view, hygiene, pest eradication programs, and efficient waste disposal are basic prevention measures that should be taken.

It is the responsibility of health units to treat patients.

The second case of myiasis caused by** Sarcophaga argyrostoma **was community-acquired (CAI).

It was a 74-year-old female patient who had recovered from a craniotomy performed for meningeoma treatment seven years prior. She had two "*artificial holes"* in the frontal region connected by a fistula with sporadically purulent discharge.

According to heteroanamnesis, after the craniotomy, holes appeared in the places where the drains were inserted.

The fistula was constantly irrigated with topical antibiotics and antiseptics. Myiasis appeared during the hot summer season. Massive irrigation was performed and 20 larvae were rinsed out.

After two days, the fistula was reassessed, and no larvae were detected. After morphological examination, *Sarcophaga argyrostoma* was confirmed as a causative agent.

The third case of secondary infection was community-acquired nasal myasis in a 35-year-old post-COVID-19 female patient. Although the COVID-19 symptoms were resolved, nasal symptoms such as stuffy nose, irritation, anosmia, sinusoidal headache, and sticky thick white discharge remained for 2 months.

She used nasal spray, decongestants, inhalation, and irrigation with saline. None of that relieved the symptoms.

Then, she performed irrigation with 70% ethanol, which provoked frequent sneezing, after which four live maggots were discharged. No additional complaints or recurrences were observed in the follow-up period. Unfortunately, we failed to perform a more detailed examination of the

expelled larvae. However, the MRI ruled out further infiltration of the larvae into the nose, sinus, orbit, face, or brain [19].

Nasal myiasis, an infestation of the nasal passages by fly larvae, is a rare clinical condition [26]. Community-acquired nasal infestation is characterized by local inflammation of the mucosa and sneezing with spontaneous elimination of the larvae, usually without leaving sequelae.

The case with aural myiasis refers to a 74-year-old female patient who suffered from skin carcinoma on the face. Malignant wounds in patients with skin carcinomas are well recognized as a predisposing factor for wound myiasis [7, 27,28]. The maggots from the patient with aural myiasis were identified as *Lucilia sericata.* The fly belongs to the family Calliphoridae.

The species is prevalent in North America and Europe. It is a facultative parasite that prefers dead tissue from hosts [7].

They are indicated as the most commonly identified species from secondary wound myiasis in patients with malignant neoplasms [28,29].

In addition, a study performed as a retrospective investigation from 2001 to 2014 identified three patients with Squamous Cell Carcinoma (SCC)-associated myiasis. In all three cases, *Lucilia* spp. was found [30]. Our findings correspond to literature data.

In 2024, we reported a cluster family of three cases with furuncular myiasis. The infestation was associated with a trip to Tanzania-Zanzibar [18]. Sporadic cases of imported furuncular myiasis from African countries, such as Tanzania, have been described in various countries worldwide [31].

Myiasis is the fourth most common travel-associated skin disease, and cutaneous myiasis is the most frequently encountered clinical form [3,7,32]

Furuncular myiasis is a type of primary cutaneous myiasis and occurs after the infestation of healthy skin by dipterous larvae, which feed on the host's living tissues and fluids [33,34].

Larvae penetrate subcutaneous tissue and form a furuncle, a nodule with a central pore that exudates a purulent fluid. The number of lesions and maggots in the furuncular nodes and their distribution in hosts varies according to fly species [7].

The patients from our study had several furuncular lesions. From each of these lesions, a single larva was extracted [18].

According to morphological features, including the body shape, size, anterior end, posterior spiracles, and pattern of spines on the body, the larvae species from all three patients were identified as *Cordylobia anthropophaga.* This species belongs to the family Calliphoridae. Our findings are consistent with the literature data.

Namely, common causative agents of furuncular myiasis are *Cordylobia anthropophaga*, *Dermatobia hominis*, *Wohlfahrtia vigil*, *Wohlfahrtia magnifica*, and *Cuterebra* spp. [3] as well as *Cordylobia rodhaini*, *Lucilia cuprina*, *Lucilia sericata*, *Oestrus ovis*, *Chrysomya spp*. [8,35].

Moreover, in 2024, 157 cases of human myiasis from Sub-Saharan Africa were reviewed. The author found 11 larvae species as causative agents. The most prevalent was *Cordylobia anthropophaga* with 66,2% [8,35].

Furuncular myiasis due to *Cordylobia anthropophaga* infestation has been endemic in West Africa for over 130 years [36].

Recently, the first case of *C. anthropophaga* furuncular myiasis is referred for southeastern Europein a Serbian patient returning from temporary work in Kenya [37]. The adult flies of *C. rodhaini* and *C. anthropophaga* deposit their eggs on soil or clothing. Contact with the host causes the larvae to hatch and penetrate the skin. A common preventive measure in endemic areas is to iron sun-dry clothes [38].

Infestation by dipterous larvae reveals a broad range of symptoms depending on the anatomical location and the maggots' burden. Treatment and outcome banks on larvae species and host health status (comorbidity) [39].

During the follow-up of our cases, two patients passed away, succumbing to primary disease complicated with severe secondary myiasis. It refers to a comatose patient from the intensive care unit and a convalescent patient with aural myiasis. Related species were *Sarcophaga* and *Lucilia sericata,* respectively. Both are facultative parasites attracted to necrotic tissue, as in our cases. Delayed treatment worsened the outcome [40].

In secondary myiasis, many necrobiontophogas fly larvae feed on a host's ulcerated necrotic wounds, neoplasms, liquid body substance, or ingested food, causing a broad range of manifestations depending on the body location and the relationship of the larvae with the host.

The infestation by fly larvae, especially in patients with end-stage cancer, may bring to mind the body's decomposition.

The profile of the patients described in this study includes them in the risk group for the development of myiasis, considering the unconsciousness in the first patient and neoplasma and advanced age in the second patient.

Other patients had no recurrent infestation and recovered completely. Sarcophaga was a causative agent of myiasis in the patient with "artificial holes" on the frontal head. Due to timely identification and treatment, the outcome was good. Myasis was resolved in two days.

Furuncular myiasis is self-limiting. Larvae leave the host.

In 8 to12 days, *Cordylobia anthropophaga* larvae should fall off (drop free to the ground). However, there is a risk of bacterial superinfection and other complications. That is why the removal of larvae is recommended. Such was performed in our patients, and the lesions were healed.

The outcome of myiasis depends on proper and timely treatment.

There are no standard protocols or guidelines for the treatment of myiasis. In either case, completely removing the larvae is the most important thing.

The simplest furuncular myiasis method is suffocation, which makes the larvae easier to catch. In some cases, a surgical incision under local anesthesia is recommended since it prevents the rupture of the larva and the resulting granulomatous reaction [37].

The larvae can pierce and penetrate both healthy and necrotic tissues; therefore, tetanus and secondary infection may occur as complications of myiasis [18].

According to that, another important goal of treatment is to prevent secondary infection.

That is why the follow-up treatment includes thorough cleansing of the affected area after removing the larvae, antiseptic dressing and debridement followed by administration of antibiotics to prevent secondary bacterial infection [34], [41, 42,43].

In the literature there is a discrepancy of the therapeutic approach in the post extirpation phase of the larvae, considering the use of tetanus prophylaxis and antibiotic treatment[18].

Although "off-label", oral and topical Ivermectin is increasingly used to treat myiasis [44].

However, a thorough inspection is recommended because dead larvae can be left trapped. Pharmacological treatment with ivermectin or tiabendazole and tetanus prophylaxis has been proposed based on literature data, but no controlled studies are available [7].

Conclusion

Nosocomial myiasis is more frequent than reported, and authorities should pay attention to its timely detection, especially in vulnerable populations.

Medical staff awareness and experience are of great importance. A collaborative approach is essential for properly identifying myiasis, causative agents, management, and prevention.

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