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ZOONOTIC MYIASIS IN EGYPT: WITH REFERENCE TO NOSOCOMIAL OR HOSPITAL-ACQUIRED MYIASIS

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Abstract

The most important insects from medical point of view are the blood suckers or the insect-borne diseases. Still others, almost non-blood suckers, but may attack man and animal to deposit their eggs or larvae of myiasis producing flies in skin, nose, eye, lung, ear, anus, vagina, and oral cavity as well as accidental gastrointestinal ones causing pathogenic condition known as myiasis causing different pathogenic conditions. Nosocomial myiasis must be noted carefully, especially in case of hospitalized patients. Myiasis is a real welfare problem and many myiasis producers are zoonotic parasites. The nosocomial myiasis illustrates an unusual problem that may confront those responsible for infection control programs. However, still little is known about such an important subject in Egypt. This review would assist in designing appropriate prevention protocols and devising suitable control strategies to overcome zoonotic and nosocomial myiasis and alleviate the economic losses.

Key words: Egypt, Zoonotic myiasis, Nosocomial myiasis

Introduction

Myiasis (/ˈmaɪ.əsɨs/ or /maɪˈaɪ.əsɨs/) is the infestation of the body of a live human being or other vertebrate by fly larvae that feed on its tissue. When the attack is directed against dead or necrotic tissue, the condition is not necessarily harmful and the effects may be of value as maggot therapy. Hope (1840) coined the term *myiasis* to refer to diseases resulting from dipterous larvae as opposed to those caused by other insect larvae (the term for this was *scholechiasis*), and described several cases of myiasis from Jamaica caused by unknown larvae, one of which resulted in death, Colloquialisms for myiasis include fly-strike, blowfly strike, and the victim or the tissue may be described as fly-blown (Show, 1974). Name of the condition was derived from the ancient Greek μυῖα (*myia*), meaning "fly". Myiasis, a term introduced by William Hope in 1840, referred to the invasion of tissues and organs of animals and human wounds and certain body cavities by the dipteran larvae, which manifests as subcutaneous furunculoid or boil-like lesions (Kathleen, 2005).

Many human skin diseases in ancient times, although different in their cutaneous manifestations and etiologies, were grouped together under the catch-all term, "leprosy." Nowadays, the skin lesions have many causes, including the infections by all classes of organisms (viruses, bacteria, fungi, helminthes and protozoa), arthropod bites and infestations, allergic and hypersensitivity reactions (Morsy, 2012a). Such was not the case for the presence of fly larvae (maggots) in tissues or wounds of man or domestic animals. The presence of live maggots in a wound or their escape from a living being's body is a condition that could not be confused with any other syndrome. As early as 520 B.C., Herodotus the "Father of History," described a case of facultative myiasis in a woman. "No sooner had she returned to Egypt, than she died a horrible death, her body seething with maggots while she was still alive." The Holy Bible alludes several times to maggots infesting human flesh. In Job7:5, the afflicted Job states "My flesh is clothed with maggots and clouds of dust, my skin rotted and fouled a fresh" In Acts 12: 23, it is recorded that King Herod died 5 days after being smitten with gangrene, during that time maggots bred in gangrenous mass. But, historical descriptions are not restricted to man. In the Hortus-Sanitatis published in Antwerp, Belgium in 1521, there are woodcuts that imply that the authors were aware of life cycle of flies that would swarm on maggot-infested meat and would attack a dead or dying animal (Greenberg, 1973).

Myiasis varies widely in the forms it takes and its effects on the victims. Such variations depend largely on the fly species and where the larvae are located. Some flies lay eggs in open wounds, other larvae may invade unbroken skin or enter the body through the nose, ears, oral cavity and/or vagina. In Patton's categorization (1922), there are two main groups of myiasis-causing species: the specific parasites, which must develop on live hosts; and the semi-specific parasites, which usually develop on decaying organic matter, such as carrion, faeces and rotting vegetation, but may also deposit their eggs or larvae on live hosts. Zumpt (1965) termed the specific parasites obligatory and the semi-specific parasites facultative. Diagnosis of myiasis depends on the demonstration of larvae on the host's tissues or organs. Correct identification of the larvae is important for the initiation of appropriate treatment and establishment of preventive measures. The risk factors that potentially cause myiasis are the exposure of ulcers and hemorrhoids, bacterial infection of wounds or natural cavities, poor personal hygiene, alcohol-related behaviors such as lack of sensitivity and sleeping outdoors, lesions resulting from itching in patients with pediculosis, and extreme lack of personal hygiene (Morsy, 2012b).

Nosocomial myiasis refers to myiasis in a hospital setting. It is quite frequent, as patients with open wounds or sores can be infested if flies are present. To prevent nosocomial myiasis, hospital rooms must be kept free of flies (Bilal *et al*, 2012). Wound myiasis occurs when fly larvae infest open wounds. It has been a serious complication of war wounds in tropical areas, and is sometimes seen in neglected wounds in most parts of the world. Predisposing factors include poor socioeconomic conditions, extremes of age, mental retardation, psychiatric illness, alcoholism, diabetes, and vascular occlusive disease. Sukontason *et al*. (2014) stated that the medical involvement of *Sarcophaga dux* larvae was not only myiasis-producing agent in humans and animals, but associated with human death investigations.

On the other hand, Al-Wahbi (2006) reported that the prevalence of diabetic foot ulcers in the Arab world in general was high, compared with Western Countries and that few studies illustrated the efficacy and associated healing mechanisms of local therapy of progenitor cells in a preclinical model of the diabetic ischaemic foot ulcer (Gu *et al*, 2007). El-Sharawy *et al*. (2012) in Egypt stated that diabetic patients with foot ulcers usually were manifested with high amputation and mortality rates and that treatment with the CD34+-enriched cells decreased wound size, accelerated epidermal healing and dramatically accelerated revascularization of wounds compared with the DC group. Assaad-Khalil *et al*. (2013) in Egypt stated that physicians in the Middle East and South Africa identified limitations relating to their patients as the main barrier to delivering care for diabetes, without giving high priority to issues relating to processes of care delivery. Further study would be needed to ascertain whether these findings reflect an unduly physician-centred view of their practice.

Abroad, nosocomial myiasis or hospital acquired myiasis was reported by many authors worldwide. The following are selected ones arranged according to year of publications. Soliman and Morsy (1976) in Saudi Arabia recommended myiasis in medicolegal practice Terra and de Siqueira (1980) in Portugal reported intra-oral myiasis. Mielke and Schlote (1980) in Germany reported hospital acquired myiasis. Jacobson *et al*. (1980) encountered two patients with hospital-acquired myiasis, a rarely reported nosocomial problem over three years. Both patients were elderly and had lengthy thoracic surgery in August in the same operating room. Larvae removed from the nares of one patient and from the chest incision of the other were *Phaenicia serricata*. There was no evidence of tissue destruction or invasion in either case. Investigation revealed several factors that contributed to the presence of flies in the operating room. After a presumed environmental access site was closed and insecticide spraying was augmented, no additional cases occurred.

Smith and Clevenger (1986) in USA retrieved sixty-five fly maggots from the nasal that immobile and debilitated patients are at risk to acquire myiasis. De Kaminsky (1993) in Honduras reported nosocomial myiasis caused by the screw larvae of *Cochliomyia hominivorax.* Josephson and Krajden (1993) in Canada found a number of fly maggots emerging from the nose and tracheostomy site of an 82-year-old woman who had been in a coma for two months in an acute care hospital in a large Canadian city. This case history indicated that the infestation was hospital-acquired and although undoubtedly an extremely rare occurrence, at least in Canada, points out the risk of myiasis in the unconscious, debilitated patient. Daniel *et al.* (1994) in Czech Republic reported a case of traumatic nosocomial myiasis caused by the green bottle fly *L. sericata* occurred in a patient hospitalized following a serious road traffic accident. The patient had suffered extensive polytrauma particularly in the facial area of the skull. A total of 50 larvae was discovered in the oral cavity, nose, paranasal sinuses and enucleated eye-socket. Projected timing indicated that the eggs were laid while the patient was hospitalized. The development of myiasis was facilitated by the mental and physical debility and dependency of the patient, numerous and deep facial necrotic wounds and a lengthy period of hot weather which led to prolonged open window ventilation of his room.

Minár *et al*. (1995) in Praha (Czechoslovakia) described a case of nosocomial myiasis of cavities caused by larvae of *L. sericata* in a patient hospitalized at the resuscitation unit after a motor car accident where he suffered fractures of the skull and other inju-

cavity of an unconscious 64-year-old man who had been admitted 18 days earlier with diabetic hyperosmolar coma. These larvae were identified as *Cochliomyia macellaria,* an organism commonly associated with myiasis. The clinical time sequence indicates that this infection was acquired in the hospital. This incident provides further evidence

ries. On the fourth day, in the nasal and oral cavity of the patient were 1^{st} and 2^{nd} instars of larvae the insect. The ova were laid in hospital. *L. sericata* is the most frequent causal agent of tissue, cavity, ocular and urogenital human myiasis in Central Europe. They reported three nosocomial ones and concluded that myiases usually attack immobile, injured or severely ill people in summer. It is important to draw attention to the hazard of myiases under exceptional conditions.

Mielke (1997) Magdeburg, Germany reported that flies larvae invaded man that was referred to myiasis. He added that recorded the cases of nosocomial myiasis documented worldwide. Twenty-three cases of this hospital infection, which have occurred in a number of countries were found in the literature, and analyzed.

Amitay *et al*. (1998) in Israel reported nosocomial myiasis in an extremely premature infant caused by *L. sericata*. Joo and Kim (2001) In Korea reported a case of nosocomial cutaneous myiasis caused by *L. sericata* (Meigen, 1826) in a 77-year-old male was found. The patient had been receiving partial maxillectomy due to the malignant tumor on premaxilla. This is the first verified case involving *L. sericata* in Taegu. Greco *et al*. (2001) in Brazil reported diabetic ulcer infested with myiasis was superimposed with *Clostridium tetani*.

Otranto *et al*. (2004) reported two species; *Rhinoestrus purpureus* (Brauer) and *R. usbekistanicus* Gan that caused nasal myiasis in horses, donkeys and zebras, and that in the past 15 years myiasis caused by *R. pur-*

pureus was reported in Egypt and by *R. usbekistanicus* in Senegal and Niger, both in horses and in donkeys.

Couppié *et al*. (2005) in French Guiana reported a bed-ridden patient with dementia who developed right nasal myiasis during his stay at Cayenne Hospital. Progression was favorable, but the nasal pyramid was partially destroyed. In zones where this fly is endemic, particular attention should be given to hospitalized patients with wounds and consciousness problems. Chan *et al*. (2005) in Hong Kong, China reported eight cases of human myiasis, who were nursing home residents with an over age of 81.8 years. Seven patients were bedridden with advanced dementia. Four patients had pre-existing wounds. Five had poor oral hygiene and four of those were on tube feeding. All of the five patients with poor oral hygiene suffered from oral myiasis. Two patients had vaginal infestations and one had wound myiasis in his diabetic foot ulcer. Seven cases were infested by *C. bezziana*, an obligatory parasite that requires living mammalian tissue for its larval develmaining case. Patients were managed with manual removal of larvae and irrigation of the site of infestation with saline. All infestations were nosocomial, being acquired in nursing homes. They concluded that the old and debilitated patients should be made aware of the need for better oral care, especially for those on tube feeding. The use of window screens in nursing homes should be encouraged to reduce the chance of flies entering the vicinity of these patients. Electrocutes could also be mounted indoors to kill flies that do enter.

Rubio *et al*. (2006) in Spain reported hospital acquired myiasis over tumor lesions. Szakacs *et al*. (2007) in Ottawa Hospital reported nosocomial myiasis in the intensive care unit. Hemmings *et al*. (2007) in western Jamaica stated that zoonotic myiasis has been remained a public health problem without significant decrease in cases admitted to the Cornwall Regional Hospital since 1999, and become a Class 1 notifiable disease to the Ministries of Health and Agriculture. Verettas *et al*. (2008) in Greece reported hospital acquired myiasis on external fixation pin sites in diabetic patients.

Sesterhenn *et al*. (2009) in Germany reported nosocomial myiasis in malignant wounds in the head and neck. Kim *et al*. (2009) Korea discovered 5 larvae inside the nose of a 76-year-old female, who was in a coma due to rupture of an aortic aneurysm. Surgery on the day of admission, and *L. sericata* larvae were found 4 days later.

Mowlavi *et al*. (2011) reported a fatal nosocomial myiasis caused by *L. sericata*. Nazni *et al*. (2011) in Malaysia reported a 73-year-old Chinese man admitted to the Accident and Emergency Premorbid Ward of a local hospital, with shortness of breath with cough and was in a semi-conscious state. He was later admitted to an intensive care unit (ICU) of the hospital. Six days after admission 5-6 maggots were recovered from the nasal cavity. The maggots were identified as the third-instar larvae of *Lucilia cuprina* Wiedmann based on the morphological characteristics. This patient was classified as having nosocomial myiasis. The presence of the third instar larvae indicated that the infestation was not more than three to four days, an adult sarcophagid identified as the *Parasarcophaga ruficornis*. Maleki Ravasan *et al*. (2012) reported nosocomial nasal cavity of a 5.5-year-old Iranian girl. Quesada-Lobo *et al*. (2012) in Costa Rica reported a case of nosocomial myiasis due to *L. cuprina*. Sharma (2012) treated oral myiasis by manual removal of maggots after using chemical agents and added that use of antibiotics reduces the duration of infection and hastens the recovery period.

Jang *et al*. (2013) in Korea reported a case of oral myiasis in a patient 37-year-old man with a 30-year history of Becker's muscular dystrophy. He was intubated due to dyspnea 8 days prior to admission to an intensive care unit (ICU). A few hours after the ICU admission, 43 fly larvae were found during suction of the oral cavity, which were third instars of *L. sericata*. Dutto *et al.* (2013) in Italy reported a case of nosocomial myiasis caused by larvae of *Sarcophaga* (Bercaea) Africa, in an ulcer on the heel of a patient with type 2 diabetes. The ulcer was dressed when the deposition occurred. An experiment was performed in order to demonstrate the ability of *Sarcophaga* larvae to move through bandages and reach purulent wounds. They added that there is bad need for particular attention, education and specific protocols in hospitals in order to avoid myiasis, which can compromise the organization's reputation for hygienic standards with possible legal consequences. Zaglool *et al*. (2013) in Saudi Arabia reported myiasis with *Sarcophaga* species in the wound of a diabetic patient. Najjari *et al*. (2014) in Mashhad reported a 63-year old man admitted to an ICU ward for investigation. On the 35th day of hospitalization, about 100 2nd instar larvae of *Lucilia* spp. were identified.

Olea *et al.* (2014) in Argentina reported myiasis caused by *Cochliomyia hominivorax* (Diptera: Calliphoridae) in a diabetic foot ulcer patient. Sukontason *et al*. (2014), in Thailand reported that although tropical climate of Thailand is suitably endowed with biodiversity of insects, flies of medical importance were not well investigated. Using information from literature search, fly survey approach and specialist's experience, we review database of *Sarcophaga* (Liosarcophaga) dux Thomson (Diptera: Sarcophagidae), one of the priorities flesh fly species of medical importance. Chaiwong *et al*. (2014) in Northeast Thailand reported that *Chrysomya megacephala* (Fabricius) (Diptera: Calliphoridae) and *Musca domestica* L., (Diptera: Muscidae) are synanthropic flies which are adapted to live in close association with human habitations, thereby making them likely mechanical vectors of several pathogens to humans. From 994 individual flies collected by a sweep net (555 *C. megacephala* and 439 *M. domestica*), they isolated 15 bacterial genera from the external surfaces, comprising ten genera of gram-negative bacteria and five gram-positive bacteria. The commonest from both species were coagulase-negative *Staphylococci*, followed by *Streptococcus* group D non-enterococci. Human pathogenic enteric bacteria isolated were *Salmonella* sp., *Shigella* sp., *Escherichia coli* O157:H7, *Salmonella typhi*, *Bacillus* sp., and *Enterococcus* sp., of which *S. typhi* is the first report of isolation from these fly species. Other human pathogens included *Staphylococcus aureus* and *Pseudomonas aeruginosa*. Not only were the number of *C. megacephala* positive for bacteria significantly higher than for *M. domestica*, but they were also carrying ~11-12 times greater bacterial load than *M. domestica*. They suggested that both fly species should be considered potential mechanical vectors of bacterial pathogens associated with human habitations year-round. Bunchu *et al.* (2014) in in Northeast Thailand isolated *Toxocara* eggs were isolated from *C. megacephala* collected from the fresh-food markets, garbage piles, school cafeterias, and paddy fields but not from restaurants, and concluded *C. megacephala* was a potential carrier of *Toxocara* eggs than *M. domestica*.

Use of myiasitic maggots in medicine: Throughout recorded history maggots have been used therapeutically to clean out necrotic wounds, an application known as maggot as maggot therapy. Fly larvae that feed on dead tissue can clean wounds and may reduce bacterial activity and the chance of a secondary infection. They dissolve dead tissue by secreting digestive enzymes onto the wound as well as actively eating the dead tissue with “mouth hooks,” two hard, probing appendages protruding on either side of the mouth (David and William, 2006). Maggot therapy-also known as maggot debridement therapy (MDT), larval therapy, larva therapy, or larvae therapy- is the intentional introduction by a health care practitioner of live, disinfected green bottle fly larvae into non-healing skin and soft tissue wound(s) of a human or other animal for the purpose of selectively cleaning out only the necrotic (dead) tissue within a wound in order to promote wound healing. Maggot therapy has a long history and prehistory. The indigenous people of Australia used maggot therapy, and so do the Hill Peoples of Northern Burma, and possibly the Mayans of Central America. Surgeons in Napoleon's armies recognized that wounded soldiers with myiasis were more likely to survive than those without the infestation. In the American Civil War, army surgeons treated wounds by allowing blowfly maggots to clean away the decayed tissue. Dr. William Baer, an orthopedic surgeon at Johns Hopkins during the late 1920s, used maggot therapy to treat a series of patients with osteomyelitis, an infection of bone or bone marrow. The idea was based on an experience in the World-War I in which two soldiers presented to him with broken femurs after having lain on the ground for seven days without food and water (William, 1931). Mumcuoglu (2001) reported that sterile maggot debridement therapy (MDT) was first introduced in the US in 1931 and was used until mid-1940s in over 300 hospitals. With the antibacterial advent, MDT became rare until the early 1990s, but re-introduced first in the US, and later in Israel, the UK, Germany, Sweden, Switzerland, Ukraine and Thailand. Maggots were approved by the FDA as a "medical device" only in 2004 (along with leeches in the same year). Maggots were the first live organism to be marketed in the US according to FDA regulations, and are approved for treating neuropathic (diabetic) foot ulcers, pressure ulcers, venous stasis ulcers, and traumatic and post-surgical wounds that are unresponsive to conventional therapies (Rita, 2004). Besides, Demirel *et al*. (2014) in Turkey stated that diabetes, coronary artery disease and low socio-economic level as well as the presence of an open, neglected wound were attributed as the most important predisposing factors that led to the development of myiasis in this patient. It should be kept in mind that the diabetic patients with open wounds may develop myiasis especially in the summer months and larvae can cause progressive wound infection. However, only a small number of flies that cause human myiasis are used in medicine (Francesconi and Lupi, 2012).

In Egypt, Steyskal and El-Bialy (1967) listed the Egyptian Diptera, among which 184 were myiasis producing dipterous flies. They were in alphabetical orders; Calliphoridae (12 species), Gasterophilidae (5 species), Muscidae (63 species), Oestridae (5 species), Piophilidae (2 species) and Sarcophagidae (97 species) and gave key for families identifications. Shaumar *et al*. (1989) established a key of all known Egyptian species of Calliphoridae to genera and species accompanied by synonyms in the light of modern taxonomic concepts. Eight genera are recorded including 14 species and added *Hemipyrellia pulchra* (Wied) as a record. So, many authors dealt with animal and zoonotic myiasis. Regarding human myisis, Hilmy (1954) reported a case of urinary myiasis caused by the cheese skipper larvae. Ghawaby and Morsy (1976) in Ain-Shams University's Hospitals reported human traumatic myiasis caused by *Wohlfahrtia magnifica*. Boulaqi *et al*. (1983) in Cairo reported aural myiasis in a hospitalized patient. Antonios and Galal (1988) reported human intestinal myiasis. El Kadery and el-Begermy (1989) reported aural myiasis caused by *W. magnifica*. Morsy and Farrag (1991) demonstrated ophthalmomyiasis due to *Oestrus ovis* and *W. magnifica* Fawzy (1991) described three human cases of otitis media associated with aural myiasis, caused by larvae of *W. magnifica* (two cases and *S. falculata* (one case). El-Serougi (1991) reported human urinary myiasis. Saleh and el Sibae (1993) reported three cases of nosocomial urino-genital myiasis due to *Piophila casei*. Fekry *et al*. (1993) found *Oestrus ovis* infesting the eyes and the nose of a camel keeper family. Tantawi and Greenberg (1993) stated that the length of the oldest maggots recovered from a body often gave an accurate estimate of the time since death. The maggots' length of *Protophormia ter-*

raenovae of known age, at peak of feeding was measured after 5 days immersion in one of 15 killing and preservative solutions, some of which are routinely used at autopsy and in forensic entomology; controls were killed in boiling water. They added that larvae of *Calliphora vicina* underwent even greater shrinkage. They concluded that which the crop length, which may be useful in age estimates of post-feeding larvae, was not altered significantly for forensic purposes in these solutions. The highly significant alterations in maggot length underscore a need for standardization in the treatment of maggots collected at the crime scene and at autopsy if their length is to be interpreted in a valid and consistent way. Fekry *et al.* (1997) reported a family of five persons infested in the eyes (5) and nose (2) with the larvae of *O. ovis*. They concluded that the physicians in the MOH rural health units should keep in mind opthalmomyiasis when dealing with non-specific catarrhal conjunctivitis particularly those people who were concerned with rearing of farm animals.

Mazyad and Rifaat (2005) found intestinal myiasis caused by *Megaselia scalaris* larvae. Tantawi *et al*. (2010) reported an accidental involvement of *L. cuprina* in MDT in Alexandria, Egypt, which proved to be safe and effective. Laboratory colonies of *L. sericata* (species regularly used in MDT) at the Alexandria Faculty of Science were renewed by *Lucilia* flies collected as third instar larvae on exposed rabbit carcasses. Flies from the new colonies were successfully used to heal the diabetic foot wounds of two patients at Alexandria Main University Hospital. Analysis of DNA sequences and adult and larval morphology then revealed that these flies were and still are *L. cuprina.* Breeding of this species in carrion in Alexandria is a new record. Despite the safety of this strain of *L. cuprina* in MDT, entomologists rearing blow flies for the purpose of wound debridement should regularly maintain high quality assurance of their species' identity to avoid possible clinical complications that may result from the introduction of an unexpected and invasive species to their laboratory colonies.

Ahmad *et al.* (2011) in Al-Minia City reported four cases of gastric or intestinal myiasis are reported. The patients were males; a 10 years old child, and 40 years old man) and females; a 18 years old girl, and a 50 years old woman. Three complained of offensive hematemesis of bright red blood, including minute moving worms in the vomitus. The fourth case complained of abdominal distention, nausea, vomiting, and diarrhea. The stool of case 2 was mixed with blood, and minute moving worms were observed in the stool. The recovered larvae were 2nd or 3rd stages of *Sarcophaga* species, and the larvae isolated from case 2 were the third stage larvae of *Sarcophaga* species, as well as 3rd stage larvae of *Oestrus* species.

Abosdera and Morsy (2013) studied the clinical pictures and pathogenesis of human oral cavity myiasis. Thirteen cases were demonstrated for the first time in Egypt, ten children and the parents of three children. The extracted larvae were *Lucilia sericata* (four cases), *Wohlfahrtia magnifica* (three cases), *Oestrus ovis* (three children and their parents) and *Musca domestica vicina* (one case). The presence of *O. ovis* in three children and their parents recommended zoonotic nosocomial myiasis. The predisposing factors were mouth breathing, incompetent lips, low socioeconomic condition, malnutrition, and inability of a child to perform daily activities due to the neurodegenerative disease. Hassan *et al*. (2014) used *L. cuprina* maggots for the treatment of an artificial wound made in the diabetic foot of rabbit. The maggots were sterilized and put directly on the wound after being dressed without any antibiotics. Several cycles of maggots were put on the wound. They found that the treatment of the diabetic foot was observed after 13 days. After this period the wound was completely healed and become free of microbial contamination. The new tissues were observed to close the wound.

Regarding animals, Hilali *et al.* (1987) examined stomachs 118 donkeys at postmortem from March 1982 to February 1983. They found *G. intestinalis* larvae clustered in groups near the boundary of the glandular and non-glandular epithelium in 98.3% of them with highest numbers in July and lowest numbers in October. Larvae were mainly attached near the pylorus and first part of the duodenum and infested 87.3% of donkeys with highest incidence in December and lowest in October. The ratio of the second and third instars of *G. intestinalis* to G. *nasalis* ranged from 71% to 29%. Morsy *et al.* (1991) collected a total of nine myiasis producing dipterous flies from Cairo and Giza abattoirs. These were *Musca d. vicina, Calliphora vicina, Chrysomyia albiceps, C. marginalis, Lucilia sericata, L. cuprina, Sarcophaga haemorrhoidalis, Wohlfahrtia magnifica* and *Oestrus ovis*. Zayed (1992) found that *Rhinoestrus purpureus* pupal duration infesting donkeys was affected by temperature but not by RH, and that the optimum temperature and RH for obtaining normal active flies were 32 degrees C and 30%, respectively. Omar (1995) stated that *Chrysomyia albiceps* was first species to arrive at carrion to lay its eggs on it almost immediately under favorable conditions. Field studies showed that although other flies arrive at the carrion shortly following *Chrysomyia*, as decomposition progresses, its larvae are the major component predominates, and the common fly emerging from carrion is its adults. First instar larvae is entirely microphagous, but the 2^{nd} and early 3^{rd} instar larvae may be facultative predaceous on other dipteran larvae (*Muscina* and *Parasarcophaga*) as an alternative food source under crowded or starved conditions. Cannibalism, 2^{nd} and early 3^{rd} instars preying on the 1^{st} instar larvae and on them has also been found. *C. albiceps* may be considered as beneficial biological control agent to help in reducing populations of carrion flies of medical and veterinary importance owing to their significant role in causing the different kind of myiasis of man and animals. The second instar is less inclined than the early 3^{rd} instar to serve as a predator. The numerous heavily sclerotized spines and fleshy processes of the robust and powerful preyer early 3^{rd} instar larvae help in subduing the prey while their strong mouth-hooks are used to penetrate the bodies of the other larvae for fluid extraction. Amin *et al*. (1997a) in North Sinai studied myiasis of sheep and goats and identified of 21 species of myiasis producing flies. The predominant species was *Musca domestica* followed by *L. sericata* and the least abundant was *M. albina*. In general, sheep were more infested with wound myiasis than goats. The overall infestation rate was high in summer, followed by spring then autumn. The least rate of infestation was winter. As to the different areas examined, the high rate of infestation was in Bir Al-Abd, followed by Al Hasanah, Al Arish, Al Sheikh-Zowaid and lastly Rafah. The factors predisposing to wound myiasis in a descending order of importance in goats were open wound, shearing wound, caseous lymphadenitis, foot rot, faecal staining, ophthalmo- or facial eczema, horn fracture, rumen fistula and lastly posterior paralysis. In sheep, the most important cause was caseous lymphadenitis followed by foot rot, then open wound and faecal staining, shearing wound, and ophthalmo or facial eczema otherwise more or less the same as in goats. It is concluded that myiasis among edible animals is a problem of veterinary and economic importance. The clinical features range between mild annoyance to severely disfiguring or fatal. Amin *et al*. (1997b) in Cairo abattoir examined1200 slaughtered sheep heads and found 104 (8.67%) were infested with *O. ovis* maggots. Sheep were parasitized all the year round with more or less maximum number (12.5%) in September. The sex ratio of parasitized sheep (female to male) was 1:2.71. A total of 556 maggots were recovered over a year with a peak in March (12.6%). The peak for the first instar larvae recovered was September (17.4%), for the second instar was March (15.7%) and for the third instar was June (11.6%). Older sheep were more infested (12.0%) with oestrosis than smaller ones (6.87%).

Amin *et al.* (1998) in Al Marg District reported sixteen species of dipterous flies. The predominant species was *Musca domestica* followed by *L. sericata* and the least abundance was *W. magnifica*. The overall abundance was in summer followed by Spring and the least was in Winter. The most attractive bait was liver for members of family Calliphoridae and meat for members of family Muscidae and Family Sarcophagidae.

Morsy *et al*. (1998a) North Sinai a total of 43 living goats out of 2040 (2.11%) was naturally infested with *Przhevalskiana silenus* (Brauer) mainly in winter. Besides, nodule caused of *P. silenus* larvae were recovered from 32 out of 98 (32.65%) slaughtered goats in Al Arish abattoir mainly in summer. The overall infestation rate among slaughtered goats was 11.68%. Adult flies were collected by baited traps from Bir Al Abd and Al Hasanah in late spring and early summer. Morsy *et al.* (1998b) in Al Arish studied the monthly and seasonal prevalence of *C. titillator* larvae in slaughtered camels. The rate of camel infestation was 25%. The highest prevalence month was October and the highest prevalence season was autumn. The three larval instars were demonstrated in the infested camels. However, the 3rd instars were the predominant stage (60.59%), followed by the 2nd instars (30.58%) and then the 1st instars (8.83%). They concluded that the control of the adult *C. titillator* and its larval instars is a must for the sake of the animal and for the human welfare. Morsy *et al.* (1999) evaluated ELISA kit hypodermosis in detecting antibodies against 2 oestrid larvae, *Przhevalskiana silenus* in goats and *C. titillator* in camels. Antibodies against *P. silenus* were detected in 38 out of 40 (95%) infested goats and negative results among the control group. With *C. titillator*, antibodies were detected in 39 out of 40 (97.5%) infested camels. But, one of the control (10%) gave false seropositivity. ELISA hypodermosis diagnosed antibodies against *P. silenus* and *C. titillator*. So, there were cross reactions between anti-*Hypoderma* antibodies and antibodies against both *Przhevalskiana* and *Cephalopina*. ELISA proved to be an easy and economic tool to diagnose myiasis infestation when direct examination was not a simple mean and/or for epidemiological studies

Besides, Hilali and Fahmy (1993) reported trypanosome-like epimastigotes in *C. titillator* larvae infesting Egyptian camels infected with *Trypanosoma evansi* and Haridy *et al*. (2011) reported Egyptian zoonotic *T. evansi*. Morsy *et al*. (1999) developed and evaluated an ELISA-Kit hypodermosis for the diagnosis of the *P. silenus* in goats and *C. titillator* in camels. Tantawi *et al*. (2010) in Alexandria used *L. cuprina* in maggot debridement as successful therapy.

As to control, Guimaraes *et al*. (1963) in Rio de Janeiro used thiabendazole® in treating a hospitalized patient with oral myiasis. Amin (1998) in Saudi Arabia used ivermectin was used in-vitro against *L. sericata* larvae. The LC_{50} was found to be 9 ppm (0.76-1.5) and the slope function was 0.59. He added that that ivermectin is a safe and very effective larvicide for *L. sericata*.

In Egypt, Nagaty *et al.* (1960) in-vitro evaluated the larvicidal efficacy of seven organic and inorganic compounds against *Musca d. vicina* and *Ch. albiceps* reared on minced meat. Morsy *et al*. (1998c) used the volatile oils of *Chenopodium ambrosioides* (American wormseed) and *Thymus vulgaris* (Tyme) against the 3rd stage larvae of *L. sericata*. The LC_{50} confidence limits were 70 ppm and 130 ppm for both volatile oils respectively. They concluded that the use of these plant volatile oils, which are widely, distributed in the Egyptian flora, cheaper, more safe and without any pollution or hazard, proved to be effective. Morsy *et al.* (1998d) evaluated the solvent extracts of three Egyptian medicinal plants in controlling the third stage larvae of *C. albiceps*.

Mazyad *et al*. (1999) evaluated the volatile oils of three plants against adult *Lucilia sericata*. The LC_{50} was 80 ppm by *Anethum graveolens*, 180 ppm by *Conyza dioscoridis* and 130 ppm by *Mentha microphylla*. The slope functions were 1.9, 1.79 and 2.2 respectively. Morsy and Mazyad (2000) feed newly moulted 3rd stage larvae of *L. sericata* on mixed *B. thuringiensis* var. *israelensis* (B.t. H-14) with minced liver in different concentrations. The LC_{50} was 9 ppm (0.76-1.5) and the slope function was 0.59. They concluded that bacterium which is safe and friendly proved to be effective against the myiasis producing *L. sericata* larvae

Mazyad and Raheem (2001) reported that *Bacillus t. israelensis* (*B.t.* serotype H-14) and its toxins have a marked lethal effect on both the eggs and the newly moulted 3rd stage larvae of *C. titillator*. The Bacillus was less effective than *Bacillus* and its toxins on both the eggs and larvae. On the other hand, the larvae were more affected by both Bacillus and Bacillus and its toxins than the eggs. Prolonged exposure time showed more lethal effect. Mazyad and Soliman (2001) evaluated the essential oil of *E. globulus* leaves or camphor against the maturation of *Oestrus ovis* larvae. Camphor at concentrations 1:0 & 1.1 showed 100% mortality rate. At concentrations of 1:2-1:6 mortality rate was between 45-98%. Besides, 38 or 27.5% of the developed pupae emerged to adults but only 36.8% were fertile. They recommended camphor oil in controlling zoonotic myiasis producer, *O. ovis*. Khater and Khater (2009) evaluated the insecticidal effect of fenugreek (*Trigonella foenum-graecum*), celery (*Apium graveolens*), radish (*Raphanus sativus*), and mustard (*Brassica compestris*) against the 3rd larval instars of *L. sericata* by ingestion assays. They found that LC_{50} values were 2.81, 4.60, 6.93, and 7.92% for fenugreek, celery, radish, and mustard, respectively. The pupation rate was strongly decreased after treatment with 16% fenugreek and celery, and adult emergence was suppressed after treatment of larvae with 8% mustard, 12% radish, and 16% fenugreek and celery oils, with emerged males exceeded the number of females. They concluded that these oils may represent new and safe potential insecticides for the control of blowflies. Khater *et al*. (2011) studied the insecticidal effectiveness of four commercially available essential oils of lettuce (*Lactuca sativa*), chamomile (*Matricaria chamomilla*), anise (*Pimpinella anisum*), rosemary (*Rosmarinus officinalis*) against 3rd larval instars of *L. sericata* regarding their sublethal concentrations on pupation rates, adult emergences, sex ratios, and morphological anomalies were also determined. They concluded that the four tested oils are inexpensive and may represent new botanical insecticides for controlling blowflies. Khater (2014) evaluated the efficacy of essential oils (EOs) of pumpkin, *Cucurbita maxima*; lupinus, *L. luteus*; garlic oil, *Allium sativum*; and peppermint, *Mentha piperita*, against the 3rd larval stage of *C. titillator* by immersion tests. The positive control group was treated with ivermectin and the negative control one was treated with distilled water and few drops of Tween 80. Larvae were reared until adult emergence. The data indicated that complete larval mortalities were reached 24 h post treatment (PT) with 2 % pumpkin, 7.5 % garlic and peppermint, 30 % lupinus, and 0.15% ivermectin. The lethal values, LC_{50s}, were 0.20, 0.44, 0.42, 0.47, & 0.03%, respectively. Pumpkin and ivermectin were 2 and 17 times, respectively, more effective than the other EOs. Ivermectin was seven times more intoxicating than pumpkin oil. Formation of pupae had been stopped after treatment of larvae with 2% pumpkin, 7.5% garlic and peppermint, 30% lupines, and 0.04% ivermectin. The adult emergence was completely ceased following treatment of larvae with 0.5% EOs and 0.04% ivermectin. The morphological abnormalities were pronounced after treatments, and peppermint oil was the foremost cause of deformation in larvae (44% PT with 7.5%) and pupae (40% PT with 2%). Pumpkin oil (6

%) proved to be the drug of choice to control *C. titillator*. EOs proved much safer than ivermectin regarding health and environmental issues.

Unfortunately, El-Azazy (1992) in Libya reported that 468 cases of screwworm myiasis were recorded in seven species of livestock and 229 humans, mainly children. Cattle and sheep were the commonest hosts. In cattle, the specific infested site was the umbilicus of neonates; in sheep in fatty tail. Myiasis reached its peak in autumn, but disappeared abruptly in winter. Screwworm distribution was confined to the northwest of Libya, with a possibility of infestation of other countries, particularly Egypt.

Conclusion

No doubt, myiasis is a problem of medical and veterinary importance worldwide. It affects human welfare both directly and indirectly. This study updates the knowledge and might help in adapting and implementing appropriate, timely, and confirmatory diagnostic procedures. When myiasis occurs in a patient after hospitalization the disease is termed nosocomial myiasis, an infrequent phenomenon, but risks. Besides, one must consider the potential neglected role of these flies in carrying pathogenic organisms as viruses, fungi, bacteria, and parasites as mechanical vectors to humans.

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