

# EPIDEMIOLOGICAL INVESTIGATION ON GENITAL MYIASIS OF BACTRIAN CAMELS IN PARTS OF INNER MONGOLIA, CHINA

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## ABSTRACT

The incidence and prevalence of Bactrian camel genital myiasis seriously endanger the health of camels and hinder the healthy development of Bactrian camel industry. In order to further understand the epidemic situation of the disease in main production areas of Bactrian camels in Inner Mongolia, China, from May to October 2021, 3 areas with severe incidences in Alxa Left Banner, Urad North Banner and Durbed Banner were selected for epidemiological investigation. Total of 2038 female camels in 21 camel herds were investigated. The results showed that the overall prevalence rate was 26.6%, the highest incidence group reached 82.6%, while the lowest group was only 1.4%. The prevalence rates of Bactrian camel genital myiasis in Alxa Left Banner, Urad North Banner and Durbed Banner was 28.0%, 23.8% and 23.7%, respectively. The pathogen of Bactrian camel genital myiasis is *Wohlfahrtia magnifica*, and the highest prevalence often occurs in July to August in each year. The prevalence rate in female camels under 5 year-old was lower than that of in adult camels, and it was highest in female camels between 5-15 years old and give birth 2-4 times and no deaths were found. The prevalence rate in free-range female camels was higher than that in half-house-raised camels, and the morbidity was lowest in fully-housed female camels. Camels grazing on pastures near the lakes and riverbanks had higher morbidity than that of in camels grazing on other pastures. Therefore, the morbidity of genital myiasis in Bactrian camels is significantly affected by age, number of deliveries, feeding method, different regions and pasture types.

**Key words:** Bactrian camel, epidemiology, genital myiasis

Genital myiasis in Bactrian camels is caused by larva of *Wohlfahrtia magnifica* in the external reproductive organs of female camels. *Wohlfahrtia magnifica* (Diptera: Sarcophagidae) is mainly found in Southeastern Europe, southern Russia, Asia, the Middle East and northern Africa (Pirali Kheirabadi *et al*, 2014). *W. magnifica* infests a wide range of animals, infects their genital tract and other open wounds. Six flocks of sheep infested with genital myiasis have been reported in China, and the identified pathogens were all *W. magnifica* (Li *et al*, 2019). Three cases of genital myiasis in a goat, a ram and a dog have been reported in Italy (Gaglio *et al*, 2011). In Fars province of Iran, 61% of all animal wound myiasis were caused by larvae of *W. magnifica* (Rafinejad *et al*, 2014). A case of gingival myiasis was reported in Xinjiang, China, and the pathogen was identified as *W. magnifica* (Zhang, 2005).

The present study investigated the prevalence of Bactrian vaginal myiasis in some areas of Inner Mongolia, China.

## Materials and Methods

### Survey area

The grassland types in Alxa Left Banner, Urad North Banner and Durbed Banner are mainly desert and semi-desert steppe, with scarce water resources and sparse vegetation. The present investigations was carried out in above 3 comparable regions with similar landscape and different soil conditions and water sources.

### Epidemiological survey

According to the life cycle of flies, comprehensive investigation was carried out by visiting farmers, distributing standardised questionnaires and electronic questionnaires on May to October in 2021. The content of the questionnaires include the basic information of the herdsman, the number and age of infected she-camels, and the rearing environment. All survey data was summarised and statistically analysed.

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### **Symptom assessment**

All of the investigated camel herds were clinically examined visually, then the infected camels were subsequently restrained using ropes one by one and careful inspection was carried out to the swelling and damage of vulva, surrounding blood stains and presence of larvae in the wound and their number.

### **Sample collection**

Five infected camels were randomly selected from each of 3 regions. Ten larvae at different stages were collected from each camel, and put them into formalin, respectively. Then, 10 third-stage larvae were collected from each of the 5 infected camel, and put them into a foam box with a length of 20 cm and a width of 10 cm that has been pre-installed with local sand, and spray a small amount of water on the surface of the sand to make the surface sand slightly wet. Finally, the box was covered with gauze, took them back to the laboratory, and cultivated it at room temperature (about 26°C), until the larvae emerged into flies.

### **Morphological observation**

Stereo Discovery.V20 microscope was used to observe the morphology of the 1<sup>st</sup>, 2<sup>nd</sup> and 3<sup>rd</sup> stage larvae (Fig 2) and the artificially hatched adult flies from 3 different regions.

## **Results**

### **Morphological observation of larva**

Clinical examination showed that the larva of 3 developmental stages existed at the wound site of most infected camels. The length of 1<sup>st</sup> instar larvae was 1-3 mm, 2<sup>nd</sup> instar larvae was 3-12 mm, and 3<sup>rd</sup> instar larva was 12-20 mm (Fig 1).

The larvae had 1 pseudoscolex, 3 thoracic segments, 8-10 abdominal segments, anus and other structures. The 9<sup>th</sup> and 10<sup>th</sup> abdominal segment were located on the ventral surface of the 8<sup>th</sup> abdominal segment, which was usually not obvious, and the 10<sup>th</sup> segment was the anal plate. The pseudoscolex had a pair of downwardly curved and sharp mouth hooks, and there was a long labrum between the two mouth hooks of the first stage larvae, but the labrum of the second stage larvae has disappeared. This was consistent with the observations of An *et al* (2019). Ring spines were covered on the dorsal and ventral sides of the larvae at each stage, and the number of spines were decreased significantly from the 7<sup>th</sup> abdominal segment. A deep cup-shaped depression was observed on the posterior surface of the 8<sup>th</sup>

abdominal segment with several pairs of conical fleshy processes at the edge of the depression.

### **Morphological observation of adult flies**

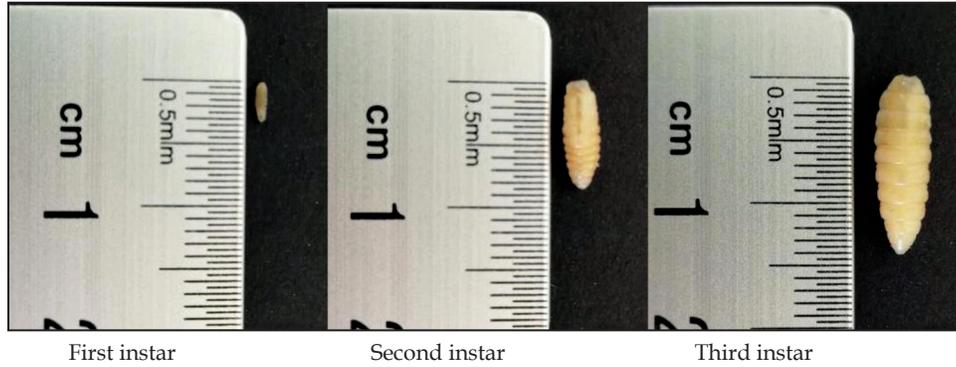
The 3<sup>rd</sup> instars were successfully eclosed after 15-20 days in laboratory, and their morphological characteristics were observed by Stereo Discovery.V20 stereomicroscope (Fig 3).

The adult fly was 9-13 mm in length, with naked compound eyes and dense silvery powder on parafrofrontalia, parafacialia and posterior eyes. When viewed from the top of the head, the width of the frons was about half that of the head, and when viewed from the side, the height of the bucca was about half that of the eye. Occiput expanded backwardly. Antennae were slightly shorter, the length of the third section was about 1.5 times that of the second section, and there were arista at the base of the third section. Thoracic segment had black background and grey powder, 3 black vertical stripes on the tergite. Lower squama was about 2 times of the upper squama. The abdomen was long and oval, with distinct black patches, and spots like water drop. The central black patches on the 3<sup>rd</sup> and 4<sup>th</sup> tergites were large and were connected to the 1<sup>st</sup> and 2<sup>nd</sup> syntergite forward, and the 5<sup>th</sup> tergite had smaller black patch. According to the characteristics of the adult fly, and its larvae were obligate parasitic warm-blooded vertebrates (Fan, 1994). The adult flies were identified as *W. magnifica*. The pathogen of genital myiasis of Bactrian camels in these 3 areas was *W. magnifica*.

### **Clinical manifestation**

According to the local lesions of affected camels, these were grouped into lightly, moderately and heavily infected camels (Fig 4). In lightly affected camels, the vulva was slightly swollen, a small amount of blood stains could be seen in the tail and hind legs, lesions caused by larvae can be seen at or near the inner margin of the vulva mucosa, with a diameter between 1-3 cm, and no secondary infection was seen. Usually less than 100 larvae were counted per camel, and no repeated infection appeared after application of pesticide.

In moderately infected camels, the vulva was significantly swollen, accompanied by bloody and fibrinous excretion, lesions and septic wounds can be seen at the vulva, with a diameter between 3-8 cm. There were 100-200 larvae in perineal area and vaginal tissue. The camels had pain response, continuous rubbing of wound area, and partial anorexia. A small number of camels had recurrence of infection after treatment with pesticide.



First instar

Second instar

Third instar

Fig 1. The body length of larvae at each stage.

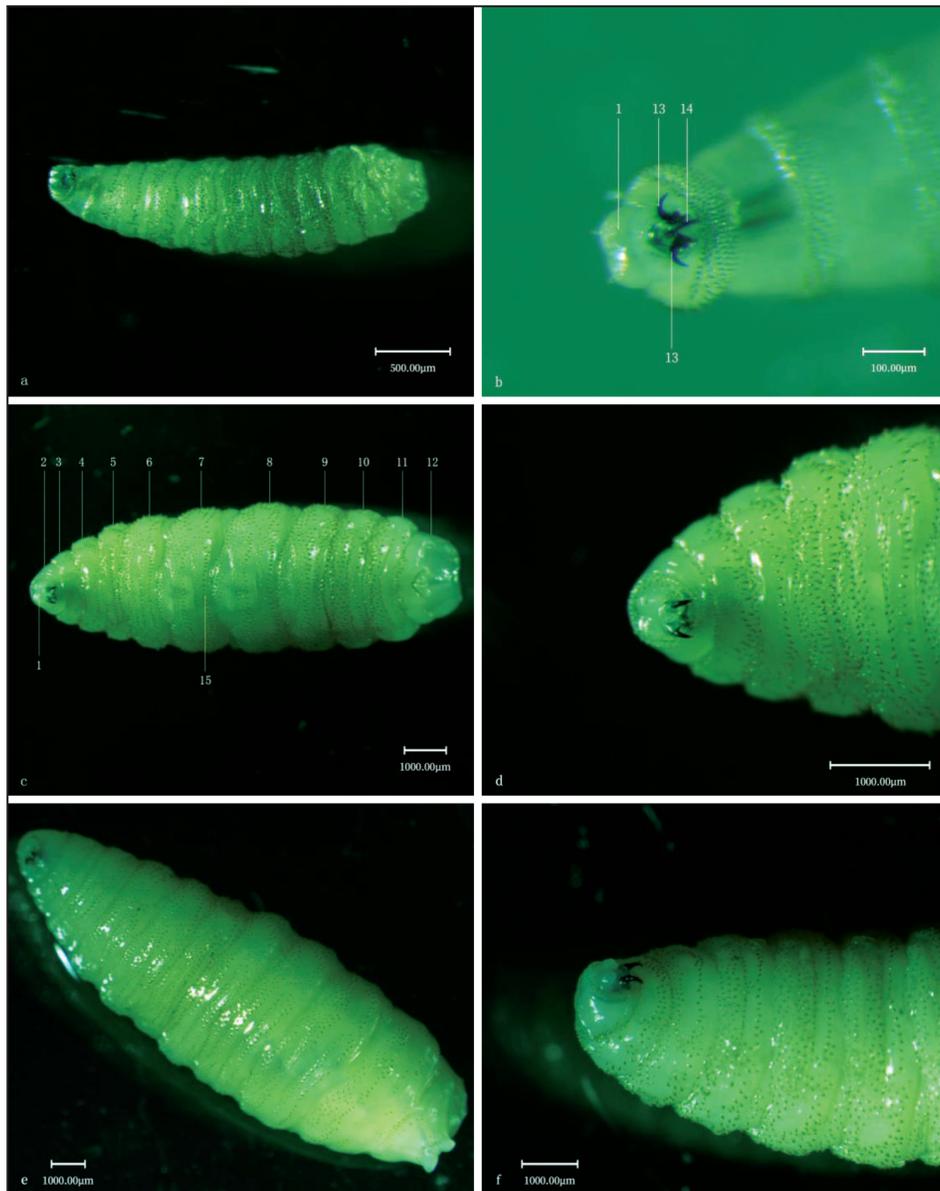


Fig 2. The larvae of each stage were observed under stereoscope.

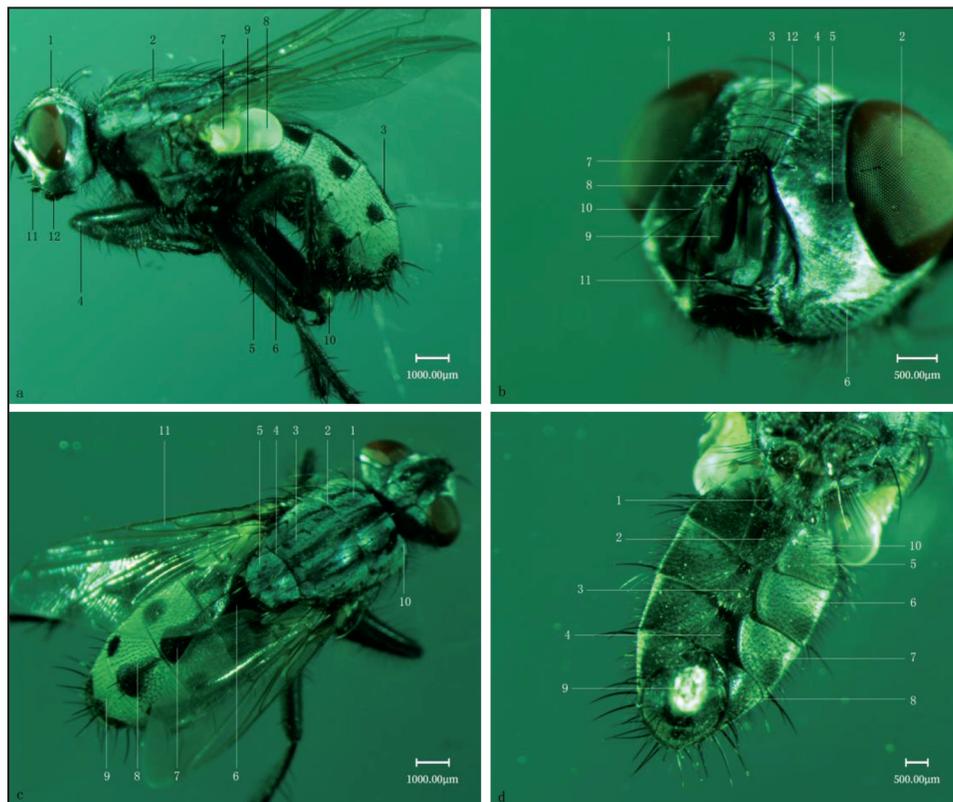
(a) First instar, (b) Head of first instar, (c) Second instar, (d) Head of second instar, (e) Third instar, (f) Head of third instar. 1 is pseudoscolex, 2-4 is thoracic segment (usually 3 segments), 5-12 is abdominal segment (usually 8~10 segments), 13 is mouth hooks, 14 is Labrum, and 15 is Spine.

In heavily infected camels, the vulva was severely swollen, accompanied by bloody and purulent excretion, severe lesions and septic wounds were seen at the vulva, with a diameter greater than 8 cm. Usually, more than 200 larvae were found in multiple larger wounds. The genital area appeared strongly deformed and swollen. All infected camels showed obvious restlessness, loss of appetite, malnutrition, prolonged disease course, and repeated

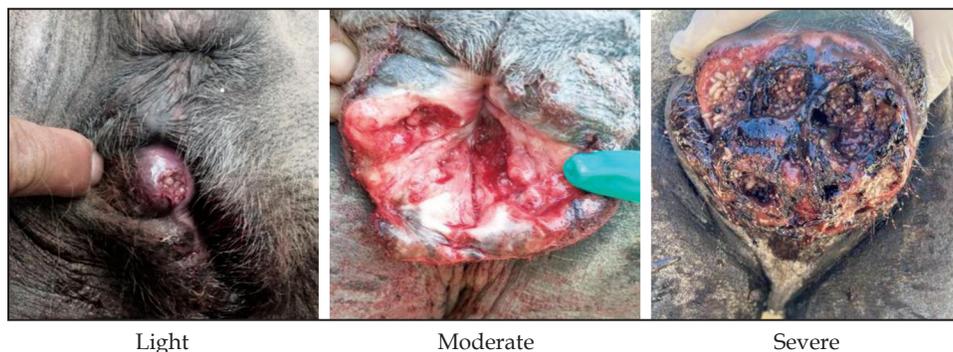
infection after treatment. Among infected camels, about 30% were lightly infected and rest of them were moderately or heavily infected camels, and most of heavily infected camels remained infected whole year.

### Epidemiological Statistics

Total of 2038 she-camels were investigated in 21 camel herds, with a minimum of 23 camels, a maximum of 300 camels per herd examined. Among



**Fig 3.** Stereoscopic observation of artificially eclosed fly (a) Side view, (b) Head, (c) Dorsal view, (d) Ventral view of the abdomen. (a): 1. Head, 2. Thoracic, 3. Abdomen, 4. Front legs, 5. Middle legs, 6. Hind legs, 7. Upper squama, 8. Lower squama, 9. Halter, 10. Terminalia, 11. Palpi, 12. Proboscis. (b): 1. Compound eyes, 2. Ommatidia, 3. Interfrontalia, 4. Parafacialia, 5. Parafacialia, 6. Bucca, 7. The first section of the antenna, 8. The second section of the antenna, 9. The third section of the antenna, 10. Arista, 11. Vibrissae, 12. Inter-frontal bristles. (c): 1. Mesothorax prescutum, 2. Scutal sulcus, 3. Mesothorax postscutum, 4. Scutellar suture, 5. Scutellum, 6. 1<sup>st</sup> and 2<sup>nd</sup> abdominal segment, 7. 3<sup>rd</sup> abdominal segment, 8. 4<sup>th</sup> abdominal segment, 9. 5<sup>th</sup> abdominal segment, 10. Humeral callus, 11. Wing. (d): 1. 1<sup>st</sup> sternite, 2. 2<sup>nd</sup> sternite, 3. 3<sup>rd</sup> sternite, 4. 4<sup>th</sup> sternite, 5. 1<sup>st</sup> and 2<sup>nd</sup> abdominal segment, 6. 3<sup>rd</sup> abdominal segment, 7. 4<sup>th</sup> abdominal segment, 8. 5<sup>th</sup> abdominal segment, 9. Anus, 10. Spiracles.



**Fig 4.** Clinical manifestations of lesions with different degrees of infection

them, a total of 491 camels were infected, and the prevalence rate found was 26.6% (Table 1). No deaths occurred. A total of 1151 she-camels from 14 camel herds were investigated in Alxa Left Banner, and 280 were infected, with a prevalence rate of 28.0%. A total of 747 she-camels were investigated from 4 camel herds in Durbed Banner, and 181 were infected, with a prevalence rate of 23.7%. A total of 140 she-camels were investigated from 3 camel herds. In Urad North Banner 30 were infected, with a prevalence rate of 23.8%. Therefore, the prevalence rate was similar in the 3 regions, and the earliest cases appeared in mid-May, then gradually increased in June and July, peaked in July and August, then gradually decreased in September and almost ended in mid-October.

Among the 21 camel herds surveyed, 15 were free-range camel herds on natural pastures, 5 were semi-free-range camel herds, and 1 was a completely house-raised camel herd. The highest incidence rate reached 82.6%, which was one of the free-range camel group; and the lowest incidence rate was only 1.4%, which was a semi grazing camel group. The average prevalence rate of grazing camels, semi grazing camels and completely house-raised camels

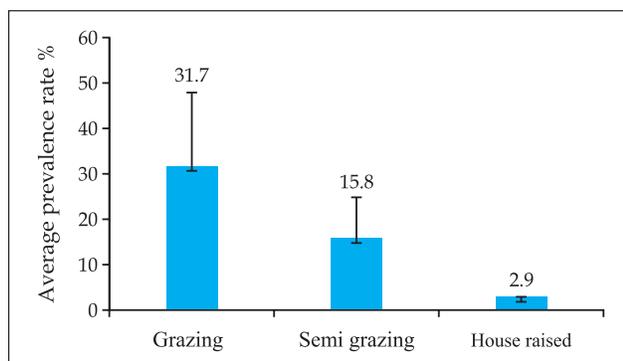


Fig 5. Average prevalence rate of female camels in different feeding methods.

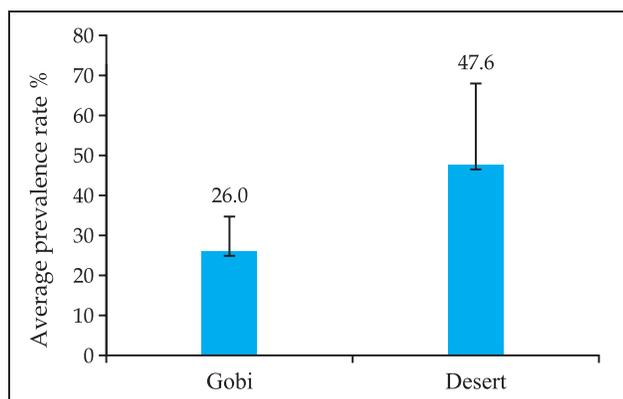


Fig 6. Average prevalence rate of female camel in different grassland types.

was 31.7%±16.2%, 15.8%±9.0% and 2.9%, respectively (Fig 5).

Among the 15 free-range camel herds, 11 camel herds were distributed in the arid grasslands of the Gobi, drinking well water; 4 camel herds were distributed in desert grasslands, with plenty of natural water sources such as lakes and river beaches. The prevalence of camels distributed in desert grasslands with lakes and river beaches was generally higher than that of camels in the Gobi steppe (Fig 6).

We further analysed 277 infected camels and found that the youngest camel infected was 7 months old and the oldest was 20 years old. Three infected camels were 1 year age, 25 camels were between 1 and 5 years and 249 camels were over 5 years of age.

We further analysed the parity of 52 infected camels and found that there were 6 camels that had not produced calves, the rest were multiparous female camels, and the female camels who had given birth to 2 calves had the highest prevalence rate (Table 2).

## Discussion

After artificial eclosion and morphological observation, the maggots collected in this survey were identified as *W. magnifica*. This was similar with the epidemiological investigated results of vaginal myiasis of Bactrian camels by Huhe *et al* (1994) in Alxa Left Banner. This indicates that vaginal myiasis of Bactrian camels caused by the larva of the *W. magnifica* has been prevalent in these areas for a long time. A case of genital myiasis of Bactrian camel caused by *Wohlfahrtia magnifica* was reported in southwest of Iran (Sazmand and Joachim, 2017). An outbreak of genital myiasis was reported in 13 Bactrian camel herds in Mongolia, and the pathogen was identified as *W. magnifica* (Schumann *et al*, 1976). In 2009, Schnur *et al* (2009) investigated the myiasis of livestock in Israel and speculated that the pathogen of 2 cases of camels genital myiasis may be the *W. magnifica*.

The clinical symptoms observed in this investigation were similar to those described by Jiang (2016) who also found swollen vulva, constant discharge of blood and channels formed by fly maggots in inner wall of vagina. In this investigation, only 3 cases were found with serious genital tract infection extending to the anus, and no infection was found in male camels.

In Alxa Left Banner, a total of 1151 female camels were investigated and the average prevalence rate was 28.0%, which was about 20% lower than the result of ErD *et al* (2012).

**Table 1.** Statistics on genital myiasis of Bactrian camels in part areas of Inner Mongolia.

Areas	No. of herds	Total No. of investigated	No. of infected	Average prevalence rate (%)
Alxa Left Banner	14	1151	280	28.0±19.2
Durbed Banner	4	747	181	23.7±5.2
Urad North Banner	3	140	30	23.8±13.5
Total	21	2038	491	26.6±16.7

**Table 2.** Relationship between the number of produced calves and prevalence rate.

Number of produced calves	0	1	2	3	4	5	6	7
prevalence rate (%)	11.5	15.4	30.8	17.3	15.4	5.8	3.8	0

The occurrence and development of myiasis are closely related to the life history of *W. magnifica*. It has been reported that the *W. magnifica* are in the form of pupae in winters and temperature is the key to their successful eclosion (Li, 2020). Hot weather from July to August and increased rainfall is ideal for the reproduction of flies, resulting in a rapid increase in the prevalence rate of genital myiasis. The average prevalence rate was higher in camels distributed near river shoals, hills and lake basins in present study. The prevalence rate of grazing female camels (31.7%) was significantly higher than that of semi grazing camels (15.8%), and this was again obviously higher than that of house raised camels (2.9%). This was mainly due to house raised camels have a small range of activities, access to clean food and water. In addition, the pens were regularly cleaned, hence there was lack of breeding conditions for flies, and the chance of camels contacting with flies was greatly reduced, thus occurrence of the disease was less.

It has been reported that the *W. magnifica* chooses to larviposition in the vagina of a female camel, which may be related to its antennae sensing surrounding chemical signals (Wang, 2019). Local farmers also said that camels with energy imbalance or postpartum vaginal inflammation were more susceptible to genital myiasis. Infection rates in juvenile camels are lower than in adult camels in most camel herds, and only 3 juvenile camels were found be infected during this investigation. This survey found that the prevalence rate of female camels over 5 years and with 2~4 parities was significantly higher than other camels.

Much attention should be paid to the prevention and control of this disease. Huhe *et al* (1994) used fly maggots powder to treat vaginal myiasis in Bactrian camels. Strengthening farmer’s awareness of the disease and rational use of drugs are also helpful to control the disease and this would promote the healthy development of camel husbandry and impart economic benefits to the camel farmers.

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