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Infection with the Sand Flea *Tunga penetrans* (Tungiasis) in a Traveller Returning from Cameroon, Africa

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**Abstract**

Tungiasis refers to human infection with adult fleas, *Tunga penetrans*. Although common throughout the tropics, tungiasis is rarely encountered by physicians in the United States such that it may be improperly diagnosed and inappropriately treated. We provide a case report of tungiasis in a traveler from Cameroon and a brief review of reported cases in the United States and Canada.

**Introduction**

Tungiasis refers to human infection with adults of the flea, *Tunga penetrans*. *Tunga penetrans* is the smallest known flea, attaining a maximum length of no more than 1 mm (Eisele et al. 2003). Common names applied to *T. penetrans* include chigoe flea, chigger flea, sand flea, bicho de pé, jigger, nigua, chica, pico, pique, and suthi (CDC 2013, Smith 2015). *Tunga penetrans* is unique in that the female flea actually penetrates and resides within the skin of its host. Although both male and female fleas take blood meals, only the female penetrates the host. After penetration, the female exhibits profound hypertrophy attaining a diameter of up to 1 cm. Eight to ten days after penetration, females begin laying eggs that are released from the host (Lefebvre et al. 2011). During the 4-6 weeks that the fleas reside in the host, hundreds of eggs may be released. Subsequently, the fleas die and are sloughed from the epidermis by skin repair mechanisms (Heukelbach 2005). After 3 to 4 days in the soil, eggs hatch and release larvae. The larvae feed on organic debris and pass through two instars before becoming pupae that are encased in cocoons normally covered in soil. The time from hatching until emergence of the adult stage is 3 to 4 weeks. The adult’s main diet consists of blood from mammals where mated females burrow underneath the skin, leaving only their abdomens exposed to lay eggs (CDC 2013, Feldmeier et al. 2014). The life cycle of *T. penetrans* is given in Fig. 1.

Although native to South and Central America, *T. penetrans* has become widely distributed throughout the tropics via trade routes, having become particularly abundant in sub-Saharan Africa. Although common throughout the tropics, tungiasis is rarely encountered by physicians in the United States such that it may be improperly diagnosed and inappropriately treated. Nearly all cases diagnosed in the United States resulted from international travel to countries in Africa and South and Central America. The only autochthonous reported human case in the U.S. was that of a man in New Orleans in 1929 who reportedly contracted the infection while sitting on infested sisal hemp imported from Mexico (Faust and Maxwell 1930), although Augustson (1942) reported *T. penetrans* from a Pacific Horned Owl (*Bubo virginianus pacificus*) at Oceanside in San Diego California. The purpose of this paper is to provide a case report of tungiasis in a traveler from Cameroon and to briefly review cases reported from the United States and Canada.

**Case Report**

During the summer of 2013, a 50 year-old male research biologist visited Bawa, Cameroon on a medical missions trip. The area comprises a tropical mountain forest with a rainy season extending from April through September. See Richardson et al. (2011) for a climatic and demographic description of the area. On 12 July, the subject noticed single small, black furuncular-like lesions on the little toe and bottom of the left foot with minor swelling and minor pain. On 13 July he returned to the United States of America. The lesions persisted with little change. On 17 July, a physician examined the subject. Patient presented furuncles on the left foot characterized by left foot paronychia of 5th digit and also an area on mid forefoot sole. The lesions were diagnosed as foreign objects with characteristic inflammation. The lesion...
The removal procedure was followed by an inflammatory response characterized by moderate pain with periodic intense pruritus associated with the lesion on the right little toe with a sterile hypodermic needle to relieve swelling, moderate-severe pain, and swelling resulted from an inflammatory response to the dead flea and fluids. This was followed a month later by necrotic discoloration (Fig. 2).

On 18 July, 8 additional furuncular lesions appeared (Fig. 3). From 18 July to 29 July, patient reported minor pain with periodic intense pruritus associated with the “new” lesions. On 23 July, patient lanced the initial lesion on the right little toe with a sterile hypodermic needle to relieve swelling, moderate-severe pain, and mild to moderate pruritus.
pruritus associated with the lesion. Limited cellulitis was also noted. A moderate amount of clear fluid was liberated. Within several hours, the pain, pruritus and cellulitis subsided.

On 30th July, all pain associated with lesions subsided. On August 2nd the patient returned to the physician. Lesions had increased in size. Patient presented large pustular lesions with centrally located black dots under toes on right side and below right hallux nail (Fig. 4), also on the mid sole and left little toe. Based on the appearance of the lesions, diagnosis was made as furnucular myiasis associated with *Cordylobia anthropophagia*. Diagnosis was made based primarily on reference to Palmieri et al. (2013).

On 8 August dermal exfoliation of 4th toe of right foot was noted. On August 9, the flea began to detach from the lesion and was removed leaving an ulcer (Fig. 5). Substantial movement of the flea was observed indicating that the flea was still alive. The flea was fixed in 95% v/v ethanol and prepared for microscopic observation that facilitated the diagnosis of tungiasis. The removed flea is shown in Figs 6-9.

On 30th July, all pain associated with lesions subsided. On August 2nd the patient returned to the physician. Lesions had increased in size. Patient presented large pustular lesions with centrally located black dots under toes on right side and below right hallux nail (Fig. 4), also on the mid sole and left little toe. Based on the appearance of the lesions, diagnosis was made as furnucular myiasis associated with *Cordylobia anthropophagia*. Diagnosis was made based primarily on reference to Palmieri et al. (2013).

![Figure 2. Necrotic discoloration following attempted surgical removal. One month after procedure.](image1)

![Figure 3. Early lesions associated with *Tunga penetrans*.](image2)

![Figure 4. Flea below right hallux nail.](image3)

![Figure 5. Flea, *Tunga penetrans*, detached from lesion on 4th toe of right foot on 9 August. Note dermal exfoliation and resultant ulcer.](image4)
On the morning of 10 August, pruritus subsided. There was substantial dermal exfoliation around all remaining lesions. Pruritus resumed on lesion on the bottom of foot with moderate to severe pain and erythematous swelling (Fig. 10). Clear fluid exuded from the lesion and walking was difficult. After about an hour, pain and pruritus subsided. It is presumed that the flea had ruptured leading to an intense inflammatory response.

On 18 August, an additional flea became partially detached and was removed (Fig. 11). In total, only 2 fleas were removed. It is presumed that the remaining fleas died and were sloughed off by normal skin repair mechanisms. By early September, lesions were completely healed without sequela.

**Remarks and Discussion**

This case report constitutes a typical course of infection with *T. penetrans*. Although common throughout much of the developing world (Feldmeier et al. 2014), tungiasis is rarely encountered in the United States and Canada and nearly exclusively in travelers returning from endemic areas. A confounding diagnostic factor is that lesions may not appear for several days (up to 30), following penetration of adult fleas (Palicelli et al. 2016). The paucity of reports of tungiasis may result in misdiagnosis and improper
Acute inflammation—characterized by erythema, edema, pain and itching—is caused by the growth of a biologically active foreign body within the epidermis, exerting pressure on the surrounding tissue.” Eisele et al. (2003) provided an excellent comprehensive overview of the course of infection with *T. penetrans*.

Tungiasis may easily be mistaken for a foreign object in early stages of infection or furuncular myiasis in later stages, as with the present case. Tungiasis is restricted to the feet 99% of the time (Thielecke et al. 2013), particularly in areas of soft skin, such as the space between toes, under toenails, and along the medial border of the feet (Cestari et al. 2007). Although rare, tungiasis should be considered a potential threat to travelers, particularly those visiting South America and Africa, as serious complications may result from secondary infections that may lead to cellulitis, abscess formation, lymphangitis, sepsis, tissue necrosis, gangrene, erysipelas, and deep mycosis (Binford and Connor 1976, Fein et al. 2001, Cestari et al. 2007). Therefore, early treatment with topical and/or parenteral broad-spectrum antibiotics is recommended (Spielman et al. 1986). Untreated tungiasis is also a risk factor for tetanus in unvaccinated individuals (Cestari et al. 2007). Additionally, inflammation may be related to the presence of endosymbiotic *Wolbachia* bacteria (Feldmeier et al. 2014), which is known to be present in *T. penetrans* (Heukelbach et al. 2004).

Sanusi et al. (1989) reviewed 14 cases of tungiasis diagnosed in the United States that appear in the scientific literature. Table 1 provides an overview of the 14 cases summarized by Sanusi et al. (1989) along with 12 additional cases from the United States and one from Canada.

Wearing socks and closed-toed shoes, especially in sandy areas (Lefebvre et al. 2011), may help reduce the risk of infection although Thielecke et al (2013) found that wearing shoes failed to reduce the incidence of infection. Application of a repellent based on coconut oil (Zanzarin) twice a day was reported to reduce infection rate by almost 100%. Treatment is extraction of fleas by enucleation with a sterile vaccionostylet, needle, or curette (Feldmeier et al. 2009, Lefebvre et al. 2011). Care should be taken not to rupture the flea, or leave any part of the flea in the lesion as this may lead to an intense inflammatory reaction (Heukelbach et al. 2001, Lefebvre et al. 2011), as described in the present case study.

**Figure 10.** Swelling around flea, *Tunga penetrans*, and lesion on plantar region of right foot following “rupture” of flea on 10 August.

**Figure 11.** Removal of flea, *Tunga penetrans*, from underneath right hallux nail on 18 August.
Table 1. Synopsis of cases of tungiasis reported in the literature from the United States and Canada, including the cases reported by Sanusi et al. 1989 and subsequently reported cases.

<table>
<thead>
<tr>
<th>Reference</th>
<th>Reported Location</th>
<th>Age, Sex</th>
<th>Number and Location of Lesions</th>
<th>History of Exposure</th>
<th>Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Faust and Maxwell 1930</td>
<td>New Orleans,</td>
<td>Adult, M</td>
<td>Many around pubic andinguinal areas, lower right abdomen</td>
<td>Sat on sisal hemp from Mexico</td>
<td>Phenolized ointment</td>
</tr>
<tr>
<td></td>
<td>Louisiana</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reiss 1966</td>
<td>New York City, New York</td>
<td>Adult, M</td>
<td>Several on both feet</td>
<td>Traveled to Lambarrene, Gabon, Africa</td>
<td>Flea removal, applying antibiotic ointment</td>
</tr>
<tr>
<td>Goldman 1976</td>
<td>Cincinnati, Ohio</td>
<td>5, F</td>
<td>4 on planter, 3 on back, 1 under breast, 1 on wrist, and 1 under nail</td>
<td>Traveled to Africa</td>
<td>Debrided, irrigated with saline, bacitracin and polymyxin B sulfate ointments</td>
</tr>
<tr>
<td>Brothers and Heckmann 1979</td>
<td>Provo, Utah</td>
<td>21, M</td>
<td>1 on toe</td>
<td>Traveled to Rio de Janeiro, Brazil</td>
<td>Curettage, antibiotic</td>
</tr>
<tr>
<td>Taubman and Spielman 1979;</td>
<td>New York</td>
<td>44, F</td>
<td>4 on 2nd and 5th toes of left foot</td>
<td>Traveled to Lima, Peru</td>
<td>Curettage</td>
</tr>
<tr>
<td>Spielman et al. 1986</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bell et al. 1979</td>
<td>Memphis, Tennessee</td>
<td>63, M</td>
<td>1 on lateral side of left heel, 1 on plantar surface, 1 under right 5th toenail</td>
<td>Traveled to Manaus near Ponta Negro, Brazil</td>
<td>Treated with cephalixin, excised fleas</td>
</tr>
<tr>
<td>Zalar and Walther 1980</td>
<td>New York</td>
<td>29, F</td>
<td>Several on both 1st toes and 5th toe of right foot</td>
<td>Traveled to Ethiopia, Tanzania, and Kenya</td>
<td>Curettage, bacitracin ointment</td>
</tr>
<tr>
<td>Poppiti et al. 1983</td>
<td>Miami, Florida</td>
<td>25, M</td>
<td>Several on lateral sides of both feet</td>
<td>Traveled to Brazil</td>
<td>Flea removal</td>
</tr>
<tr>
<td>Armin et al. 1985</td>
<td>Maywood, Illinois</td>
<td>70, M</td>
<td>1 under toenail of 2nd toe right foot</td>
<td>Traveled to Africa</td>
<td>Flea removal, topical antibiotic bacitracin</td>
</tr>
<tr>
<td>Wentzell et al. 1986</td>
<td>Hanover, New Hampshire</td>
<td>17, M</td>
<td>2 on periungual area of 1st and 5th toes on right foot</td>
<td>Traveled to Brazil</td>
<td>Curettage, dissected bluntly, antibiotic ointment</td>
</tr>
<tr>
<td>Milgrau and Headington 1988</td>
<td>Ann Harbor,</td>
<td>30, M</td>
<td>1 on 2nd toe</td>
<td>Traveled to Canaima National Park, Venezuela</td>
<td>Not Given</td>
</tr>
<tr>
<td></td>
<td>Michigan</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sanusi et al. 1989</td>
<td>Shreveport,</td>
<td>24, M</td>
<td>2 on 3rd and 2nd toes of right foot</td>
<td>Traveled to Zaire, Africa</td>
<td>Flea removal</td>
</tr>
<tr>
<td></td>
<td>Louisiana</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dalton and Haldane 1990</td>
<td>Halifax, Nova Scotia, Canada</td>
<td>43, M</td>
<td>1 on sole of right foot</td>
<td>Traveled to Venezuela</td>
<td>Debrided with sterile needle</td>
</tr>
<tr>
<td>Burke et al. 1991</td>
<td>Greenville, North Carolina</td>
<td>18, M</td>
<td>Distal lateral portion of right great toe</td>
<td>Traveled to Brazil</td>
<td>Excised with scalpel blade and base curetted, topical polymycin B &amp; bacitracin ointment</td>
</tr>
<tr>
<td>Lowry et al. 1996</td>
<td>Fort Bragg, North Carolina</td>
<td>Adult, F</td>
<td>Feet and toes</td>
<td>Traveled to Brazil</td>
<td>Curettage</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mashek et al. 1997</td>
<td>Buffalo, New York</td>
<td>33, F</td>
<td>Many on planter and periungual areas on both feet</td>
<td>Immigrated from Somalia and lived in Kenya</td>
<td>Debrided, curettage, dicloxacillin, bacitracin ointment</td>
</tr>
<tr>
<td>Lucchina et al. 1997</td>
<td>Massachusetts</td>
<td>30, F</td>
<td>Several on 1st and 5th toes of right foot</td>
<td>Traveled to Brazil</td>
<td>Curettage, electrodesication</td>
</tr>
<tr>
<td>Darmstadt and Francis 2000</td>
<td>Seattle, Washington</td>
<td>1, F</td>
<td>5th toe of right foot</td>
<td>Adopted from Paraguay</td>
<td>Nail clipped back, unroofed and debrided</td>
</tr>
</tbody>
</table>

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Table 1 Cont.

<table>
<thead>
<tr>
<th>Authors</th>
<th>Location</th>
<th>Age, Gender</th>
<th>Parasite Location</th>
<th>Source of Parasite</th>
<th>Treatment/Procedure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fein et al. 2001</td>
<td>Cincinnati, Ohio</td>
<td>4, F and 6, M</td>
<td>Many on soles and toes of both feet</td>
<td>Adopted from Liberia, Africa</td>
<td>Flea removal, antibiotics</td>
</tr>
<tr>
<td>Brane et al. 2005</td>
<td>Cincinnati, Ohio</td>
<td>29, F</td>
<td>1 on 1st toe of left foot</td>
<td>Traveled to Kenya</td>
<td>Flea removal, antibiotic ointment</td>
</tr>
<tr>
<td>Van Buskirk et al. 2006</td>
<td>Detroit, Michigan</td>
<td>55, F</td>
<td>Right heel</td>
<td>Traveled to Tanzania</td>
<td>Excisional biopsy</td>
</tr>
<tr>
<td>Hager et al. 2008</td>
<td>Texas</td>
<td>24, F</td>
<td>1 on left first toe</td>
<td>Traveled to Tanzania, Africa</td>
<td>Curettage, and light hyfrecation</td>
</tr>
<tr>
<td>Appiah et al. 2013</td>
<td>Baltimore</td>
<td>14, M</td>
<td>20 on right foot, 9 on left foot, soles and sides</td>
<td>Traveled to Guyana, South America</td>
<td>Topical 10% albendazole ointment, curettage</td>
</tr>
</tbody>
</table>

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Literature Cited


