

Zeitschrift:	Acta Tropica
Herausgeber:	Schweizerisches Tropeninstitut (Basel)
Band:	20 (1963)
Heft:	2
Artikel:	Early references to the occurrence of "Tunga penetrans" in tropical Africa
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DOI:	https://doi.org/10.5169/seals-311105

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From the Liberian Institute of the American Foundation for Tropical Medicine
(President and Research Director: Dr. M. J. Miller).

Early References to the Occurrence of *Tunga penetrans* in Tropical Africa.

By R. HOEPLI*.

I. Some remarks on the early knowledge of *Tunga penetrans* in Tropical America and the West Indies.

It is generally agreed that the original home of the sandflea *Tunga (Sarcopsylla) penetrans* are the tropical and subtropical parts of the American continent between about 30°N and about 30°S, and the West Indies. The sandflea became known to the Spaniards not long after Columbus had landed at Guanahani on 12th October, 1492. The earliest report is that by OVIEDO, 1526. It is found in Chapter VIII (teste GUYON, 1870, p. 786), in which he deals with the diseases from which the Spaniards suffered who had been left on Haiti by Columbus on his first voyage before he started his homeward passage in January 1493. Most of these Spaniards belonged to the crew of the flagship Santa Maria which had been wrecked on a coral reef on Christmas 1492.

For several hundred years writers dealing with the sandflea did not add much to OVIEDO's description. They even repeated the error of OVIEDO who believed that the sandflea could pass its entire life-cycle on a person, as either the eggs or the larvae were deposited in the tissue and in this way the infection could spread on the same person. This erroneous belief is still found in publications of the second half of the nineteenth century and even at the beginning of the twentieth (HENNING, 1904).

Subsequently quite a number of writers have mentioned sandflea infection from Tropical America and the West Indies. Among the early authors is Gonzalo Ximenez de Quesada (1538) whose manuscripts, as far as the present writer could ascertain, have not yet been printed but have been frequently quoted by Piedrahita, Bishop of Panama, one of the early historians of New Grenada, in his book, published at Antwerp in 1688. Quesada in 1538 led a military expedition up the Magdalena River and ascending the high plateau of Bogotá remained for four days in a *Tunga* infested town, Sorotoca, which had been abandoned by its inhabitants. As a result the soldiers suffered so severely that they could hardly

* Resident Director.

walk, and the situation improved only after some Indian women showed the Spaniards how to remove the embedded insects (ROULIN, 1870). In this connection it may be mentioned that more than 300 years later, in November 1862, a French Division under Bazzaine had a similar experience in the Mexican war during its encampment at Perote and a year later, in 1863, French troops again suffered from the sandflea at Orizaba (GUYON, 1870). In 1558 THEVET mentioned sandflea infection among the Indians of the French possessions in South America. PISO, 1648, referred to the occurrence of the sandflea in Brazil.

Among eighteenth century authors are SLOANE, Vol. II, 1725 (West Indies), ATKINS, 1734 (West Indies), CATESBY, Vol. II, 1743, who gave one of the early illustrations of *Tunga* (West Indies and southern part of North America), ULLOA¹, 1748, BAJON, 1777, 1778 (Cayenne and French Guiana), MOSELEY, 1792 (West Indies), CHAPPE D'ANTEROCHE, 1772, p. 20 (Mexico).

Among writers of the early nineteenth century who mention sandflea infection are WINTERBOTTOM, 1803 (West Indies) and RENGER, 1832, 1835 (Paraguay).

Besides the few authors mentioned, there are many others who refer to the sandflea in America and the West Indies. From all these publications one may draw the conclusion that *Tunga penetrans* was widely established and known in Tropical America and the West Indies when the first conquerors arrived.

II. The early knowledge of *Tunga penetrans* in Tropical Africa.

Whereas we have from the first half of the sixteenth century up to the present numerous references to *Tunga penetrans* infection from Tropical America and the West Indies, where the local population knew how to deal with the infection, corresponding reports from Africa are rare and of much later times. Until recently there still existed the widespread erroneous belief, expressed in some publications and also in text-books (e.g. CASTELLANI & CHALMERS, 3rd ed. p. 862, 1919; HERMS, 3rd ed. p. 410, 1948; SIMONS, Vol. II, p. 897; 1953; MANSON-BAHR, 15th ed. p. 673, 1960) that the sandflea did not occur in Africa prior to 1872, when it was introduced by a British ship, the Thomas Mitchell, sailing from Rio de Janeiro to Ambriz (Angola). There are, however, a few much earlier reports on the occurrence of *Tunga penetrans* in Africa.

In examining them we can discard a brief paper by E. JEAN-SELME, 1908, in which he quoted a paragraph from LIND's "An

¹ ULLOA's description of the sandflea is based on the observations of Joseph de Jussieu who as botanist took part in the scientific exploration of South America under the command of Captain Ulloa.

Essay on Diseases incidental to Europeans in Hot Climates", 1768 (French translation 1785). In his book LIND refers to a British military expedition against the French ascending the Senegal River in 1758. The expedition was described by the accompanying army surgeon. The soldiers had severe losses and suffered especially from the very many insects which filled the air: mouches sauvages, mouches de sable et cousins. "La quantité de mouches de sable et de cousins était excessive et pouvait aussi passer pour un fléau." R. BLANCHARD, 1910, has already pointed out that mouche de sable cannot refer to the sandflea, as the latter has no wings and cannot fly.

ATKINS in "The Navy Surgeon", 1734 (Physical Observations on the Coast of Guinea) mixed up *Dracunculus medinensis* and *Tunga penetrans* and apparently regarded the latter as a small kind of *Dracunculus* found in the West Indies. However, he does not refer to the small kind (*Tunga*) as occurring in Africa. In consequence ATKINS' statements cannot be used to prove the existence of *Tunga* on the West Coast of Africa in the first half of the eighteenth century.

HIRSCH in his "Handbook of Geographical and Historical Pathology" (Vol. II, p. 364, 1885) takes the view that the sandflea was introduced into Africa by a British ship in 1872. He refers, however, to a statement by a Russian physician that the sandflea had existed in Africa for a long time. HIRSCH doubted this statement as he could not find any supporting data.

The present author has checked the statement, which is found in Grum's *Gesundheitsfreund*² (Friend of Health) No. 19, pp. 145 to 147, 1838 (Mittheilung des Staabsarztes SKRIPITZIN, derzeit ältesten Chirurgen des Seehospitals in Cronstadt — Zeitschrift für die gesamte Medizin Bd. 13, Auszüge p. 77, 1840). SKRIPITZIN states regarding the sandflea:

«Sein Vaterland ist nicht ausschließlich America, wie bisher ein großer Teil der Naturforscher glaubt, und ihn deswegen *Pulex americanus* nennt. Dieser Floh findet sich auch schon bei Negern auf ihrer Überfahrt von Africa nach America vor. Daher findet sich dies Insect in Mozambique, Congo und anderen Gegenden Africa's, mit welchen Negerhandel getrieben wird.»

FALKENSTEIN, 1877, stated that *Tunga penetrans* had apparently been introduced into Africa in 1872 by a ship coming from Brazil, but had been observed by ADANSON already in 1759 in Senegal. ADANSON, 1759, p. 298, points out the very large number of sandfleas in the huts of the local inhabitants and the intolerable

² A Russian journal of popular medicine which was apparently well-known in the middle of the 19th century, as it is mentioned in Turgenev's "Fathers and Sons" by the nihilist Bazarov.

irritation caused by them. Strangely enough he does not mention the burrowing in the skin, but points out that the sandflea does not jump higher than three or four inches.

KARSTEN, 1865, and HESSE, 1899, held the view that the fleas mentioned by ADANSON cannot have been *Tunga penetrans* as the characteristic burrowing in the skin is not mentioned. HESSE also points out the occurrence of a great number of fleas which are not *Tunga* tormenting the population in other parts of Africa and refers to publications by STANLEY, 1890, and by STUHLMANN, 1894. One has to admit that it is surprising that ADANSON did not speak of the burrowing in the skin. On the other hand he mentions that the sandfleas were of such a small size that one could hardly see them, that their attack caused a very strong itching and that they could not jump higher than 2-3 inches which is characteristic of *Tunga*. Therefore it seems to the present writer rather likely that the flea mentioned by ADANSON was *Tunga penetrans*.

Regarding another eighteenth century author, BARBOT, there can be no doubt that he referred to *Tunga*. BARBOT was Agent-Général of the Royal Company of Africa and Islands of America in Paris. His publication, "A description of the coasts of North and South Guinea and of Ethiopia Inferior vulgarly Angola, etc." was published in an English translation in London in 1732. In Book I, Chapter II, p. 32, he writes:

«Men are here plagued with a sort of handworms, which in the *Caribee* islands in *America* are called *Chiques*, and work themselves into the soles of the feet, and the heels, becoming the more troublesome and insupportable, in that they are not to be rooted out, if they have once time given them to lay their eggs there. But of these also more shall be said in the supplement, when I come to the description of *Martinico*.»

HENNING, 1904, has drawn attention to a still earlier publication which in his opinion refers to *Tunga penetrans*. SAMUEL BRAUN, a physician of Basle, published in his "Schiffahrten", Basle, 1634 (Report on his first voyage to West Africa in 1611-13) the following:

«Es (Congo) ist aber das ungesundeste Land / als man weit und breit findet / denn neben allerley bösen Krankheiten / bekommt man auch eine Plag / welche sie Peysy nennen / sind kleine Würmlein / wie sie im Käss pflegen zu wachsen mit schwarzen Köpfen. Welche Würmlein in des Menschen Fundament oder After / wie auch in die Händ und Fuß zwischen den Nägeln und dem Bette kommen / und dasselbig auffressen / daß es in 3 oder 4 Tagen ein Loch im After so groß machet / daß man ein Faust darein stoßen könnte / davon der Mensch in neun Tagen sterben muß / wo man nicht beyzeiten hilft. Aber ehe man die Sachen lernet kennen / kostet es oft viel Volk. Die einige Hilfe ist / eine Lemonen spalten oder schälen / und also ganz in das Fundament stecken. Also werden sie durch die Schärfe der Lemonen getötet und zerstöret / daß der Mensch wiederum zu seiner Gesundheit kommt. Allein / wie ange-

deutet / muß man nicht zu lange warten / sonst wäre es nicht möglich zu helfen.» (Quoted from HENNING, 1904, p. 310).

In the present writer's opinion it is probable that BRAUN's statements deal with a combination of two different unconnected pathological conditions. Sandfleas, even if they would attack in very large numbers, could never produce a tissue necrosis at the anal opening within 3-4 days of a size that a hole is formed in which one could place a fist³. Such destructions caused within 3-4 days might perhaps be due to a certain fly larvae but not to sandfleas. On the other hand BRAUN's statement that the parasites are found between the bed and the nails on hands and feet makes it likely in the present writer's opinion that in part the cases mentioned by BRAUN were cases of *Tunga penetrans* infection.

HESSE, 1899, discusses the question why *Tunga penetrans* infection in the seventeenth century did not spread, very different from the experience after *Tunga* had been reintroduced in 1872 by the British ship, Thomas Mitchell. HESSE's explanation with which the present writer agrees is that in the seventeenth century there was, apart from traffic on the old caravan routes, not very much communication between the different parts of Africa. The various tribes had as a rule little contact with each other, except when they were at war or made slave raids. According to PIGAFETTA, 1591, while the kingdom of the Congo, for example, had from various places on the coast communications with other countries, there was, however, little contact along its inland borders with its neighbours as they were hostile and there were hardly any roads except those going from the capital, San Salvador, to the coast.

Furthermore in places with *Tunga* infection the people gradually learnt how to cope with the situation. In consequence it is possible that in certain places the infection died out.

Neither LOPEZ in the account of his stay in the Congo, published by PIGAFETTA, 1591, nor the numerous seventeenth century writers except BRAUN, dealing with the West Coast of Africa, mention the sandflea. Its first definite record is, as already mentioned, by BARBOT, 1732.

A new development in the history of *Tunga penetrans* infection in Africa begins in 1872. The British ship, Thomas Mitchell⁴,

³ It should be added that in old neglected cases of *Tunga penetrans* infection rapidly spreading ulcerations with deep reaching tissue necrosis have sometimes been observed (TROUSSAINT, 1902).

⁴ The ship Thomas Mitchell was a sailing vessel of 499 tons, built at Dumbarton on the Clyde in 1851, owner T. Mitchell, Port Glasgow. The writer wishes to thank the National Maritime Museum, Greenwich, for the information.

which had brought coal from England to Rio de Janeiro went in ballast from Rio to Ambriz (Angola) where it arrived in September, 1872. The crew suffered from sandfleas which also infected visitors to the ship. The sandfleas were carried to the shore by the infected persons and also in old coffee sacks (PECHUEL-LOESCHE, 1882, teste HESSE, 1899, p. 523). Within a short time the local population suffered terribly from *Tunga* infection especially as the cause of the suffering was at first unknown.

Before the end of 1872 the sandflea had been carried southward to São Paulo de Loanda and northward to the Congo. The rapid spread was due to coastal vessels which called at larger ports along the coast. BÜTTIKOFER's description of Liberia, 1890, shows how quickly a country can be infected with *Tunga penetrans*. During BÜTTIKOFER's first visit in 1879-1882 no sandfleas were noticed. They were, however, soon afterwards introduced by Kroo boys who worked on the ships sailing along the coast. On his second visit, 1886-1887, BÜTTIKOFER found Monrovia heavily infected. While *Tunga penetrans* spread rapidly along the West Coast, its transportation deeper inland needed more time. It took place mainly by the old caravan routes but also by expeditions (e.g. by Stanley's Emin Pasha Relief expedition of 1887). HESSE, 1899, traced in considerable detail the spread of the sandflea across Tropical Africa from West to East Coast, where it was first noticed in 1895. In the same year Senegalese soldiers carried the sandflea to Madagascar (BLANCHARD, 1899; TROUSSAINT, 1902); in 1898 it had reached Zanzibar.

It was found not only on the plains but also in the Usambara mountains at an altitude of 1600-1700 meters⁵. Towards the end of the century Indian troops and labourers returning from Africa brought the sandflea to Bombay and later to Karachi.

It has long since been known that besides man various domestic and even wild animals may be infected by the sandflea. A gorilla kept in captivity had to have his sandfleas removed by two negroes every fortnight (FALKENSTEIN, 1877). Mice, rats, cats, dogs and especially pigs are important reservoir hosts for the infection of human beings. Future work is needed to decide how many species of sandfleas are involved.

It has likewise been noted and mentioned by several writers that, as *Tunga penetrans* needs dry sand or soil for its develop-

⁵ The altitude at which *Tunga penetrans* is able to exist depends on the distance of the locality from the Equator. In America on the Equator the sandflea was found at 3,100 m. (at Tuquerres, Pasto Province, Colombia, which is situated practically on the Equator), at Santa-Fé de Bogotá at 4°23'8"N. at an altitude of 2661 m. (teste GUYON, 1870).

ment, the number of sandfleas greatly decreases during the rainy season.

Similarly, as mentioned before from America, *Tunga penetrans* infection played a role in military campaigns in Africa. JOLLY, 1926, describes how in 1915 during the East African Campaign a British force which was temporarily stationed in an abandoned German camp suffered badly from sandfleas. In the Second World War, during the military operations in Abyssinia, *Tunga penetrans* infection was common among Indian troops (SIMONS, Vol. II, p. 897, 1953).

As well as soldiers, porters accompanying expeditions and workers on plantations occasionally suffered from sandflea infection to an extent that they were greatly hampered in their work (HESSE, 1899, pp. 528-529). One has also to consider that in neglected cases sandflea infection may cause rapidly developing ulcerations with necrosis which eventually cripples the person by the loss of toes or a whole foot (HESSE, 1899, p. 524; TROUSSAINT, 1902). Especially in days gone by, when *Tunga penetrans* infection was widespread and often not properly treated, mutilations of the feet were not rare and the infection was therefore of not inconsiderable economic importance.

The rapid spread of *Tunga* across the tropical part of the African continent from the West to the East Coast within about twenty-five years after its reintroduction in 1872 is remarkable. It is on the other hand interesting to observe the influence on the prevalence of the infection of improved living conditions and of the knowledge of how to remove the parasite from the skin. BÜTTIKOFER, 1890, on his second visit to Liberia, 1886-1887 found in Monrovia so many people infected with the sandflea that everywhere in the streets one saw persons walking painfully, often with bandaged feet, and occasionally showing the loss of one or more toes. Even about ten years ago *Tunga penetrans* was not rare in Monrovia but at that time the method of removing the insect was common knowledge and the number of infected persons had greatly decreased. Nowadays, with most people wearing shoes, and with much improved streets, it is very hard to find a *Tunga*-infected person in Monrovia.

Discussion and Summary.

The first reference to the sandflea, *Tunga penetrans*, in Tropical America goes back to OVIEDO, 1526; in Africa on the other hand the first report which undoubtedly refers to *Tunga* is that by BARBOT, 1732. Another eighteenth century writer, ADANSON, 1759, refers to the occurrence of sandfleas in Senegal which were in all

probability *Tunga penetrans*. There is even a seventeenth century reference by SAMUEL BRAUN, 1624, to a pathological condition which in part may have been *Tunga* infection. It is in any case certain that sandflea infection on the West Coast of Africa existed in the eighteenth century and probably earlier but only in restricted areas.

Comparatively few communications, such as existed at that period, are the most likely cause for the limitation of the infection. With the exception of SAMUEL BRAUN no other seventeenth century writer mentions what might have been sandflea infection. Sandfleas are also not mentioned by PIGAFETTA, 1591, who published Lopez' report on his stay in the Congo in the last quarter of the sixteenth century.

It is very probable that *Tunga penetrans* was introduced in the seventeenth century from Tropical America into Africa. This is indicated by the name "chique" used in Senegal which had already been employed for a long time in French Guiana and the West Indies. "Chique" apparently derived originally from "Sika", an American Indian word.

The reintroduction of *Tunga penetrans* in 1872 by the British ship, Thomas Mitchell, which had sailed from Rio de Janeiro to Ambriz (Angola) was followed by a rapid spread of the sandflea along the West Coast of Africa and subsequently along the trade routes and by expeditions across the tropical part of the whole continent. From East Africa, which it had reached about 1895, it was carried to Zanzibar in 1898. Senegalese soldiers brought it to Madagascar in 1895. Returning Indian labourers and soldiers carried the sandflea to Bombay and later to Karachi.

In the East African Campaign of the First World War and especially in the Abyssinian Campaign of the Second World War *Tunga penetrans* infection caused considerable morbidity among the Indian soldiers.

Porters accompanying expeditions and workers on plantations likewise suffered from sandfleas. When *Tunga penetrans* infection was widespread and often not properly treated, mutilations of the feet were not rare and the infection was therefore of not inconsiderable economic importance.

Improved living conditions and improved streets in cities and towns, accompanied by the knowledge of how to deal with the infection, lead, as in the example of Monrovia, Liberia, to a considerable reduction of the infection. In Monrovia, which in 1890 was heavily infected and where only about ten years ago *Tunga penetrans* was still quite frequent, the infection is nowadays practically extinct.

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Zusammenfassung.

Der erste Bericht, der mit Sicherheit das Vorkommen von *Tunga penetrans* in Afrika (Senegal) beweist, ist von BARBOT, 1732. Ein anderer Autor des achtzehnten Jahrhunderts, der den Sandfloh (in Senegal) erwähnt, ist ADANSON, 1759. Er berichtet jedoch nicht über das sehr charakteristische Einbohren in die Haut, weshalb einige Autoren annehmen, daß es sich in ADANSON's Fall nicht um *Tunga penetrans* gehandelt haben könne. SAMUEL BRAUN, 1624, erwähnte bereits ein Krankheitsbild vom Kongo, das nach der Beschreibung zu urteilen anscheinend zwei nicht miteinander zusammenhängende Infektionen zu einer Einheit zusammenfaßt. Er erwähnt «kleine Würmlein», die sich unter die Nägel der Hände und Füße einbohren, so daß mit einer gewissen Wahrscheinlichkeit angenommen werden kann, daß es sich zum mindesten bei einem Teil der Fälle um *Tunga penetrans*-Infektion gehandelt hat. Kein anderer der Autoren des siebzehnten Jahrhunderts, die über die afrikanische Westküste geschrieben haben, erwähnt den Sandfloh, und obgleich es sicher ist, daß die Infektion im achtzehnten und möglicherweise im siebzehnten Jahrhundert bestand, so war sie örtlich beschränkt infolge des geringen Verkehrs zwischen den verschiedenen Volksstämmen. Es ist sehr wahrscheinlich, aber nicht zu beweisen, daß die im 18. Jahrhundert und möglicherweise im 17. Jahrhundert in Afrika in umschriebenen Gegenden bestehenden *Tunga*-Infektionen vom tropischen Amerika eingeschleppt wurden.

Die 1872 durch das englische Schiff *Thomas Mitchell* verursachte Wiedereinführung des Sandflohs von Brasilien nach Angola führte infolge des viel stärkeren Verkehrs zunächst zu einer schnellen Verbreitung an der Westküste und etwas langsamer quer über den tropischen Teil Afrika's von der Westküste zur Ostküste, wo der Sandfloh bereits um 1895 auftauchte. Danach

wurde er nach den der Ostküste vorgelagerten Inseln, Zanzibar 1898, Madagascar 1895 (durch senegalesische Truppen) und gegen Ende des Jahrhunderts nach Indien verschleppt.

Bessere Lebenshaltung und moderner Städtebau können, wie das Beispiel Monrovia's zeigt, die Infektion der Bevölkerung stark verringern und endlich zum Verschwinden bringen.

Résumé.

La première référence qui, sans que l'on puisse en douter, prouve la présence de *Tunga penetrans* en Afrique (Sénégal) date de BARBOT, 1732. ADANSON 1759, un autre auteur du 18^e siècle, signale également la puce chique au Sénégal. Cependant, comme il ne mentionne pas la pénétration caractéristique du parasite dans la peau, d'autres savants supposent qu'il ne s'agissait pas dans le cas d'ADANSON d'une *Tunga penetrans*. En 1624 SAMUEL BRAUN avait décrit une maladie du Congo dont il semble qu'elle se composait de deux infections indépendantes. BRAUN parle de « petits vers » localisés sous les ongles des mains et des pieds. On peut admettre qu'il s'agissait là, du moins dans quelques cas, d'infections dues à *Tunga penetrans*. Aucun autre auteur du 17^e siècle, rapportant sur la côte ouest de l'Afrique, ne mentionne la puce chique quoiqu'il soit certain que cette infection ait été présente dans ces régions en tout cas au 18^e siècle, mais peut-être aussi au 17^e. La maladie devait être alors localisée en raison du sédentarisme des populations. Il est probable, mais pas prouvé, que *Tunga penetrans* ait été introduite en Afrique au 18^e siècle (ou au 17^e siècle déjà) en provenance de l'Amérique tropicale.

La réintroduction en Angola de la puce chique brésilienne, en 1872, par le bateau anglais Thomas Mitchell, donna naissance à une expansion rapide de l'infection sur la côte ouest en raison de l'augmentation des communications. Le passage du parasite à travers la zone tropicale du continent, de la côte ouest à la côte est, où il apparaît en 1895, fut un peu plus lent. De là, *Tunga penetrans* gagna les îles voisines (Zanzibar, 1898 ; Madagascar, 1895, importée par des troupes sénégalaises) pour arriver aux Indes vers la fin du siècle.

De meilleures conditions hygiéniques et un urbanisme plus moderne, comme Monrovia en est la preuve, permettront seuls de réduire fortement l'infection pour enfin la faire disparaître.