

The Tiny Terminators

Mosquitoes and Diseases

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The miniscule needles of mosquitoes do not always stop at mere scratches on the skin, but inflict lethal stabs to exterminate over two million human lives annually! Know the hows and whys from this article.

A frequently asked question by curious listeners during discourses on mosquitoes is on the role of mosquitoes in the spread of HIV. The available scientific data rule out any such mosquito theory but scientists do differ on the theoretical possibility of HIV virus adapting to a mosquito species as many other mosquito-borne viruses did. The chances are very feeble, mainly due to the meagre viral density in peripheral blood (viraemia) that could facilitate the evolution of a mosquito-virus system. Mechanical transmission is impossible because mosquito mouth parts are not analogous to hypodermic syringes, as believed by many. The forward propulsion of saliva and backward suction of blood are facilitated by two different tubules (hypopharynx and food canal, respectively), thereby nullifying the possibility of viral transfer along with saliva (*Figures 1 and 2*). Though the HIV threat may be shelved as an untenable theory, we have enough mosquito-borne diseases to worry about.

The concept of mosquitoes as disease transmitters (vectors) was evolved during the 1870s, when Patrick Manson, a British doctor in China, showed that mosquitoes might be vectors of lymphatic filariasis or elephantiasis. This hypothesis was proved to be valid later. In India, three species of mosquitoes – *Culex quinquefasciatus*, *Mansonia annulifera* and *Mansonia uniformis* are the known transmitters of lymphatic filariasis. It is prevalent in humid and hot areas of Africa, the Americas, Asia and numerous islands in the Pacific Ocean. Filariasis is a social and cosmetic disease due to its manifestations of elephant like legs and ex-



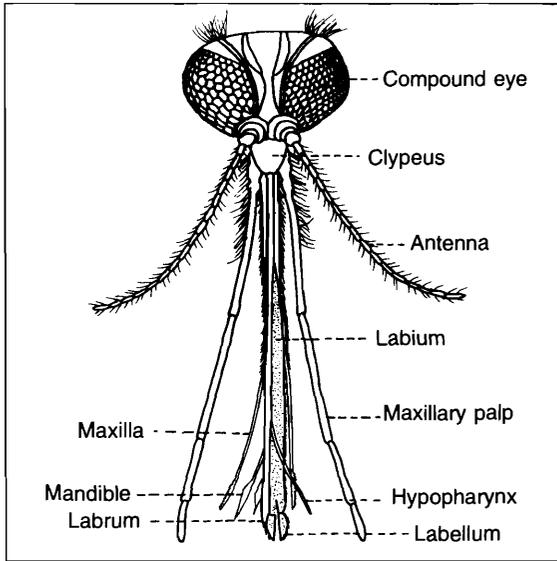


Figure 1. Head of a female mosquito.

traordinary enlargement of many parts of the body. It is a curable disease, if diagnosed in the initial stages. But after the onset of the aforesaid chronic manifestations, except for expensive cosmetic surgery, there is no available medical cure.

It was Manson's motivation that prompted Ronald Ross, a British physician in the Indian Medical Service, to pursue the malarial parasites in mosquitoes. This he did meticulously against all odds and proved the mosquito theory of malaria transmission in 1897. It was a surprise to his friends to see him emerge as a hero in this field, because one thing he clearly did not want to be was a doctor! His adolescent dreams by turns were to be a painter, composer, mathematician, poet and novel-

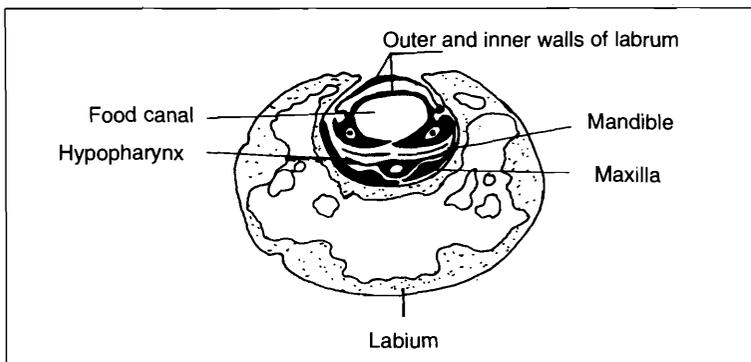
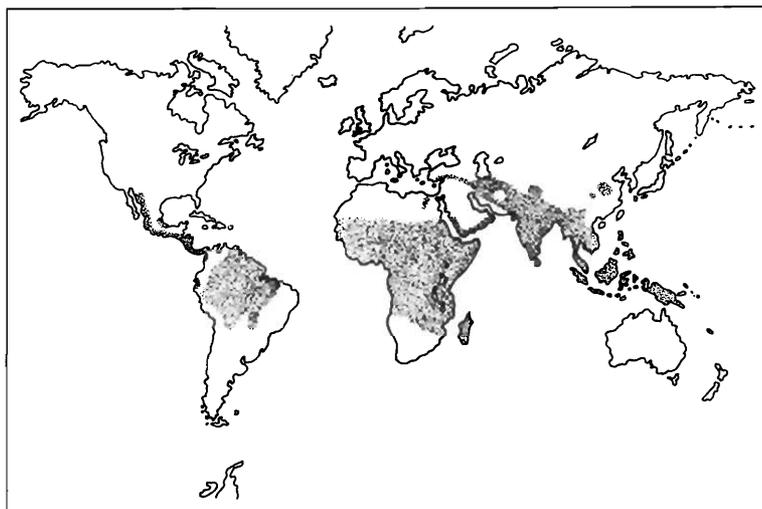


Figure 2. T.S. of mosquito mouth parts.



Figure 3. World distribution of malaria (shaded regions).



¹In India out of 52 *Anopheles* species, 10 are known to spread malaria.

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ist. Subsequent to this Nobel Prize winning discovery (1902), Italian zoologists headed by G B Grassi proved that only *Anopheles* mosquitoes could transmit malaria¹. A century after Ross's pathbreaking discovery, malaria still continues to be one of the biggest killer diseases in the world, (Figure 3) especially in tropical countries with 1-2 million deaths every year, the bulk of which is in tropical Africa. The killer malaria parasite is *Plasmodium falciparum*, while the remaining three species, *P. vivax*, *P. malariae* and *P. ovale* are non-killers. Because malaria is largely a disease prevalent in poorer countries it has not been attracting commercial interests of the industry. Investments in malarial research were low until recently, when the cyber giant Bill Gates declared malaria as one of his charity priorities. This is expected to give the much-needed fillip to malaria vaccine research programmes in different parts of the world.

The developed countries have woken up to another mosquito borne disease recently – West Nile encephalitis. In August 1999, New York City witnessed a major outbreak of this viral disease with 7 casualties. Following this unacceptable calamity in a developed nation, the Clinton administration announced \$7.7 million for the fiscal year 2000 to combat this disease. West Nile encephalitis is originally a disease of birds, especially crows, transmitted by *Culex* mosquitoes, which can also leap to man

under suitable circumstances and cause encephalitis. As the name indicates, the disease was originally reported from Africa and is prevalent in the Middle East, Asia and some parts of Eastern Europe. The New York outbreak was the first of its kind in the Western Hemisphere. Fortunately, this disease has not been reported to affect man in a massive way in India.

West Nile might only be a future threat, but its two cousins, Japanese encephalitis and dengue, have already made inroads into our country with occasional outbreaks in different states. The former is presently distributed in most Asian countries. It is essentially an animal virus and domestic pigs are its major reservoirs. Pigs in turn get the infection from birds, especially pond herons and egrets, through mosquitoes. Man is just an accidental link in the disease cycle and is not a source of infection for further transmission.

An abnormal number of abortions among pigs is an indicator of a potential outbreak in a locality. It does not manifest as a fatal disease by cerebral involvement in all patients. It is estimated that out of 300 infections with the virus only one results in symptomatic illness. Mortality is predominant among children below 14 years. The estimated global mortality due to this disease is about 10,000 (Figure 4). Fortunately, an effective

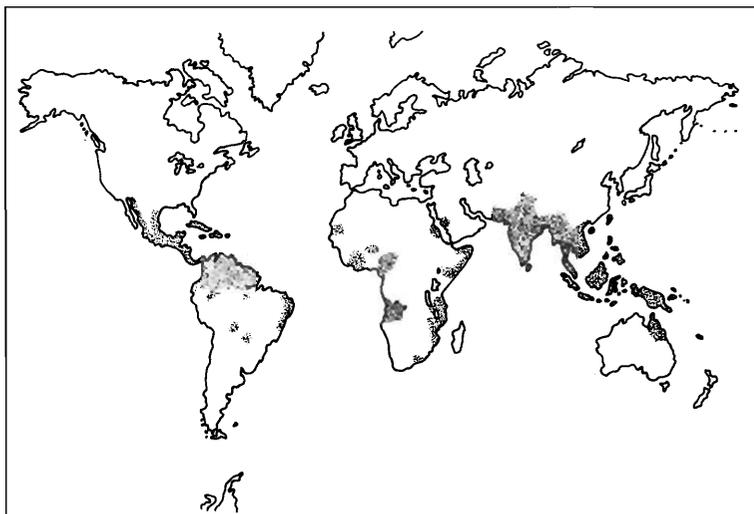
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Figure 4. World distribution of Japanese encephalitis.



Figure 5. World distribution of dengue (shaded regions).



vaccine is available for its prevention. *Culex vishnui* group of mosquitoes, which prefers to breed in paddy fields, is the vector of Japanese encephalitis.

Dengue viruses exist as four types; type 1 to 4. The disease is endemic throughout the tropics, particularly Asia, the Pacific and Caribbean (Figure 5). Infection with one strain imparts life long immunity to that particular strain. But, infection with another strain at a later stage could trigger severe manifestations of the disease known as dengue haemorrhagic fever and dengue shock syndrome, which could be fatal. The severe form causes leakage of blood plasma from the circulatory system leading to very low blood pressure, which could cause death. Similar to most viral diseases, dengue also does not have a specific curative drug, but a vaccine is hopefully in the offing. The annual global casualty due to this virus is approximately 24,000. The vector of dengue, *Aedes aegypti* is a domestic mosquito, preferring containers and water tanks as breeding sites. In Delhi, where there was a severe outbreak with over 370 deaths in 1996 (which was due to type-2 virus), this mosquito was found breeding profusely in desert coolers. Because of its proximity to human dwellings, control of this species is feasible with minimum efforts.

Aedes aegypti transmits a related virus in Africa and America

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causing yellow fever leading to about 30000 deaths per year. This is a fatal haemorrhagic disease similar to dengue haemorrhagic fever. The disease is associated with jaundice, hence the name. Yellow fever is believed to have originated in Africa; however, the first recorded outbreak was in Mexico in 1648. It was originally a monkey disease, transmitted by *Aedes africanus* in African forests. Due to stringent quarantine measures and compulsory vaccination for overseas travellers, this virus has not been introduced to India, but is considered as a potential danger. Another hypothesis of its non-introduction to India is attributed to the incompatibility of the Indian strain of *Aedes aegypti* to yellow fever virus. This hypothesis is yet to be confirmed.

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Chikungunya, O'nyong nyong and Ross river fever are closely related to acute dengue fever. Chikungunya is transmitted by *Aedes aegypti* and *Aedes africanus*; O'nyong nyong by *Anopheles gambiae* and *Anopheles funestus* and Ross river fever by different species of *Aedes* and *Culex*. Chikungunya is widely prevalent in Africa, Southeast Asia and is suspected to be present in India. O'nyong nyong is exclusively African and Ross river fever Australian. Fatalities have not been reported due to these three diseases.

Besides the major mosquito-borne diseases mentioned above, there is a big list of animal viral diseases (zoonoses) mediated by these little creatures, which have been reported to trespass the human domain occasionally in different parts of the world (Table 1). Rift valley fever, which is prevalent in Africa, is one of them. An outbreak of Rift valley fever occurred among sheep

Disease	Annual morbidity	Annual mortality
Malaria	100-300 million	1-2 million
Filaria	120 million	Nil
Dengue	50 million	24000
Japanese encephalitis	30000-40000	10000
Yellow fever	0.2 million	30000

Table 1. Global morbidity and mortality due to major mosquito-borne diseases.



Table 2. Potential mosquito-borne viral diseases.

Sl. no.	Name of virus	Known geographic distribution	Sl. no.	Name of virus	Known geographic distribution
1	Apeu	Brazil	22	Mayaro	South America, Trinidad, South Africa
2	Banzi	South Africa	23	Mucambo	Brazil
3	Bunyamwera	Africa, Americas	24	Murray Valley encephalitis	Australia
4	Busuquara	Brazil	25	Murutucu	Brazil
5	Bwamba	Uganda	26	Oriboca	Brazil
6	California encephalitis	USA	27	Oropouche	Trinidad, Brazil
7	Calovo	Czechoslovakia	28	Orungo	Africa
8	Caraparu	Brazil	29	Ossa	Panama
9	Catu	Americas	30	Piry	Brazil
10	Eastern Equine encephalitis	North America	31	Pixuna	Brazil
11	Germiston	Africa	37	Sindbis	Africa, Australia, Far East
12	Guama	Americas	38	Spondweni	South Africa
13	Guaroa	Brazil	39	St. Luis encephalitis	Americas, Belize
14	Ilesha	Americas, Africa	40	Tahyna	Czechoslovakia, France, Africa
15	Ilheus	Americas, Caribbean, Belize	41	Tensaw	USA
16	Inkoo	Finland	42	Trivittatus	USA
17	Itaqui	Brazil	43	Venezuelen Equine encephalitis	Americas
18	Kemerovo	Siberia	44	VSV-Indiana	USA
19	Kunjin	Australia	45	Wesselsbron	South Africa
20	Madrid	Panama	46	Western Equine encephalitis	Belize, Americas
21	Marituba	Brazil	47	Wyeomyia	Americas

flocks in 1994 in Tamil Nadu. Scientists have sounded alarm bells to guard against this potential threat. There was an outbreak of this viral disease in Saudi Arabia in September 2000 claiming 16 lives, which happened to be the first of its kind outside the African continent. Waiting on the wings around the world, but yet to cross our border, there are about fifty other mosquito-borne viral diseases, most of them of the animal kingdom, and occasionally some of the humans (*Table 2*).

With 3000 plus species, occupying every nook and corner of the globe within the 8° to 40° C temperature zone, the mosquito has been giving a tough time to man in an antagonistic co-existence since time immemorial. Who shall have the last laugh?

Suggested Reading

- [1] G Harrison, *Mosquitoes, Malaria and Man: A History of the Hostilities since 1880*, John Murray, London, 1978.
- [2] WHO *Geographical distribution of arthropod-borne diseases and their principal vectors*, 1989.
- [3] G Cook, *Manson's Tropical Diseases*, 20th Edition, Tropical Health Technology, London, 1996.
- [4] J A Rozendaal, *Vector Control: Methods for use by individuals and communities*, World Health Organization, Geneva, 1997.

Websites

- [1] www.iuhs.webnet/GMP/SAM/chapters/07_INFECTIOUS_DIS/viral_zoonoses.html#28/00
- [2] www.ciesin.org/docs/001-613.html

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Our schoolbooks glorify war and hide its horrors. They inculcate hatred in the veins of children. I would teach peace rather than war. I would inculcate love rather than hate.

Albert Einstein