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Research Article

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Biology of Vectors and Agent of Skin Disease and River Blindness (Onchocerciasis) In the World

Hassan Vatandoost[1,2]*

[1]Department of Medical Entomology and Vector Control, School of Public Health, Tehran University of Medical Sciences, Tehran, Iran

[2]Department of Environmental Chemical Pollutants and Pesticides, Institute for Environmental Research, Tehran University of Medical Sciences, Tehran, Iran

***Corresponding author**
Hassan Vatandoost, Department of Medical Entomology and Vector Control, School of Public Health, Tehran University of Medical Sciences, Tehran, Iran and Department of Environmental Chemical Pollutants and Pesticides, Institute for Environmental Research, Tehran University of Medical Sciences, Tehran, Iran

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Abstract

Objectives: *Blackflies are the aquatic insects. A total of 1800 species of this insect have been identified worldwide. The main important species is Simulium damnosum. They suck the blood of other animals and human. They spread several diseases, including river blindness (Onchocerciasis)) in Africa and America. The agent of disease is Onchocerca volvulus. The aim of this review article is to explain the bio ecology, medically importance, different control measures for agent and vector of disease and status of resistant to drug and insecticides in the agent and vector.*

Methods: *In this research all, the relevant information regarding the topic of research is research through the internet and used in this paper. An intensive search of scientific literature was done in "PubMed", "Web of Knowledge", "Scopus", "Google Scholar", "SID", etc.*

Results: *The results indicated that this insect play an important role in disease worldwide. Ivermectine (Mectizan®) drug is an important for killing the agent of disease. Several larvicides recommended by WHO for vector control. Due to high use of drug and pesticide for control of disease , the resistant to drug and pesticide have been reported worldwide.*

Conclusion: *Monitoring and mapping of drug and insecticide resistance is a major factor for disease control worldwide.*

Keywords: Blackflies, River Blindness, World, Control

Background

Blackflies belong to Order: Diptera, Su-order: Nematocera, Family: Simuliidae, Genus: Simulium, Species: *Simulium damnosum, S. neavei , S.callidum , S. metallicum, S. ochraceu.* They are called as: black fly, buffalo gnat, turkey gnat and white socks. Common names of black flies in other languages are: German: kribelm, Norweigan: knott, Polish: meszkowate , French: simulie, Swedish: knott, Central America: bocone, South America: Chile, Jerjel. 1800 known species of black flies (of which 11 are extinct). The majority of species belong to the immense genus Simulium. Most black flies sucking the blood of other animals and human. Although the males feed mainly on nectar. They are usually small, black or gray, with short legs and antennae. They are a common nuisance for humans. They spread several diseases, including river blindness in Africa (*Simulium damnosum* and *S. neavei*). In the Americas (*Simulium callidum , S. metallicum* and *S. ochraceu*) are exist. Eggs are laid in running water in batches ranging from 100-600 (Figure.1).

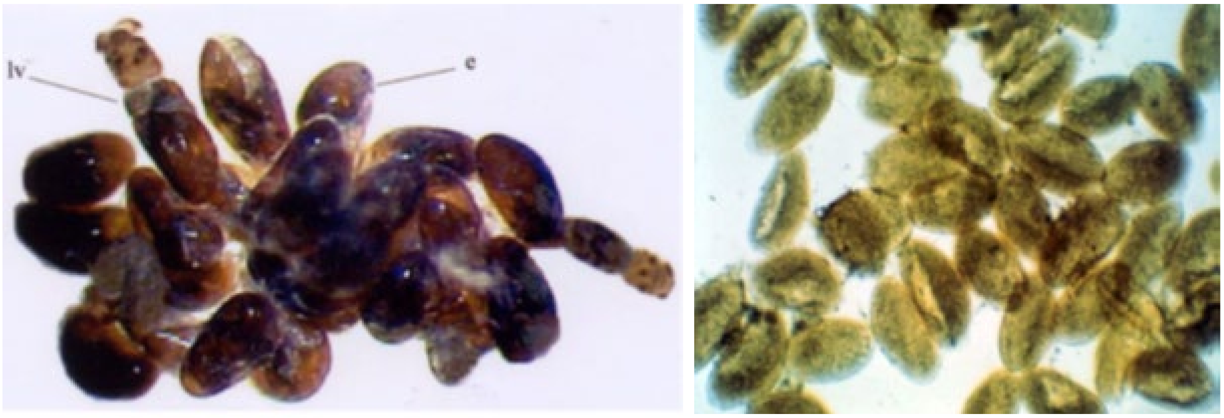
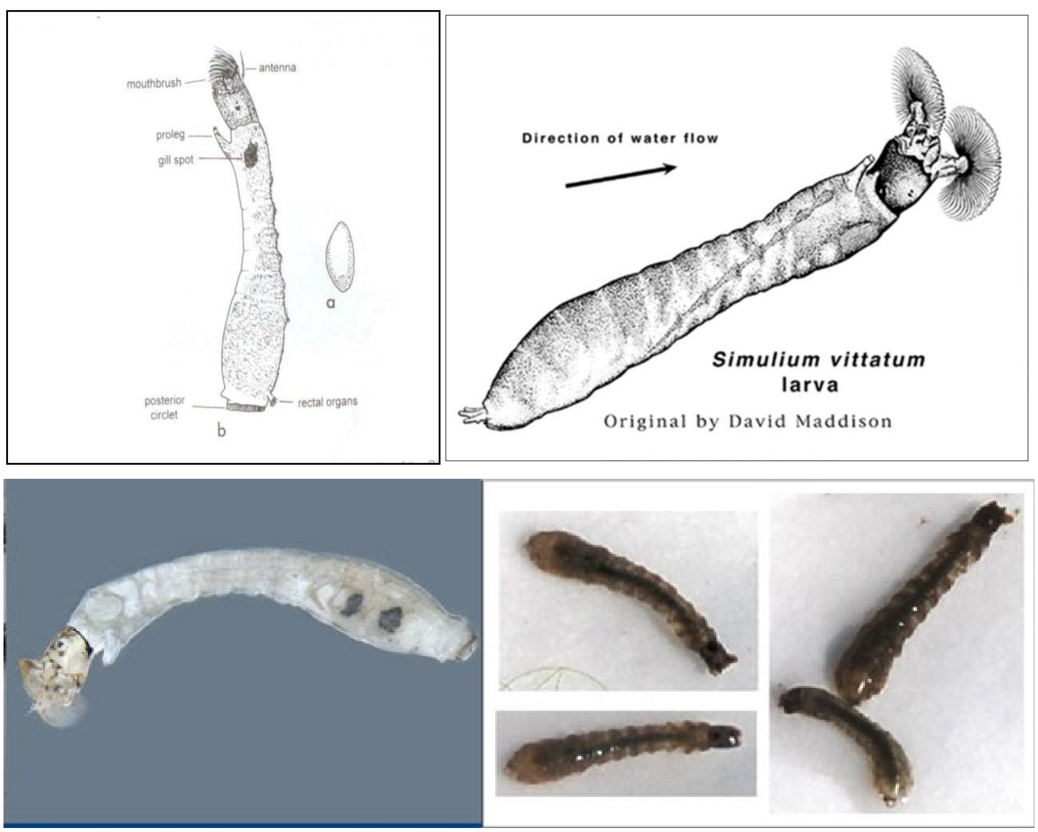


Figure 1: Eggs of blackfly

The larva have 6-9 instar. They are feeding on organic material. They have delicate cephalic fans comprised from a series of rays. The filter feeding mechanism is passive with debris being filtered directly from the passing current. Another morphological feature of the larva to facilitate feeding is a series of hooks at the rear of the abdomen. These are used to anchor the larva to a silk pad which the larva produce. The combination of the silk pad and abdominal hooks maintain the larvae position on the substrate in the fast flowing water. The cephalic fans are held into the current and periodically contracted to bring food particles to the cibarium by the mandibular brushes. On the body lying ventral to the head is a proleg which serves to produce two water currents traveling to the left and right of the head and into the cephalic fans. Samples of gut content has shown that bacteria can contribute a considerable portion of the diet. Larvae attach themselves to rocks. Breeding success is highly sensitive to water pollution.The larvae use tiny hooks at the end of the abdomen to hold on to the substrate, using silk holdfasts and threads to move or hold their place. They have foldable fans surrounding their mouths. When feeding, the fans expand, catching passing debris (small organic particles, algae and bacteria).Black flies depend on lotic habitats to bring food to them. They will pupate under water and then emerge in a bubble of air as flying adults. During emergence, they are often preyed upon by trout (Figure.2) .



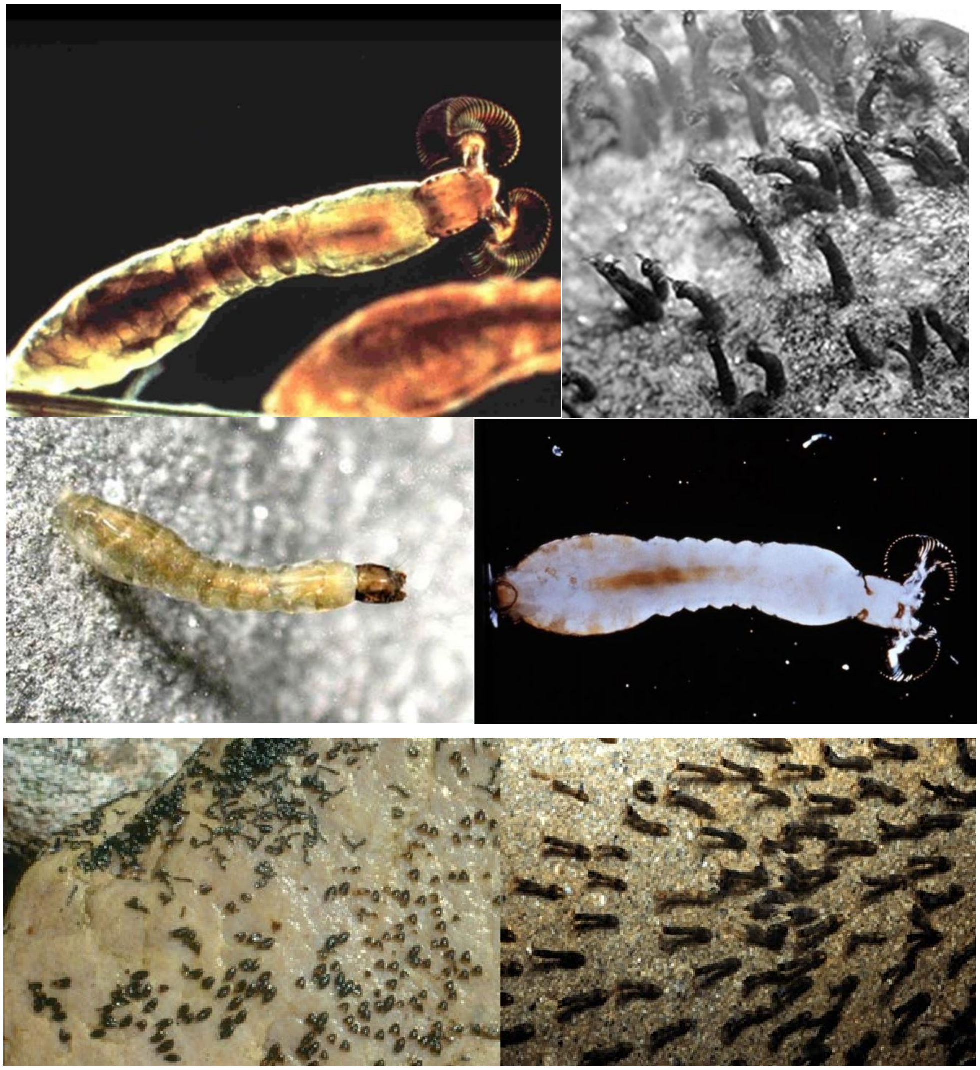


Figure 1: Larvae of blackfly

Pupae have the filaments on the anterior end (Figure.2)

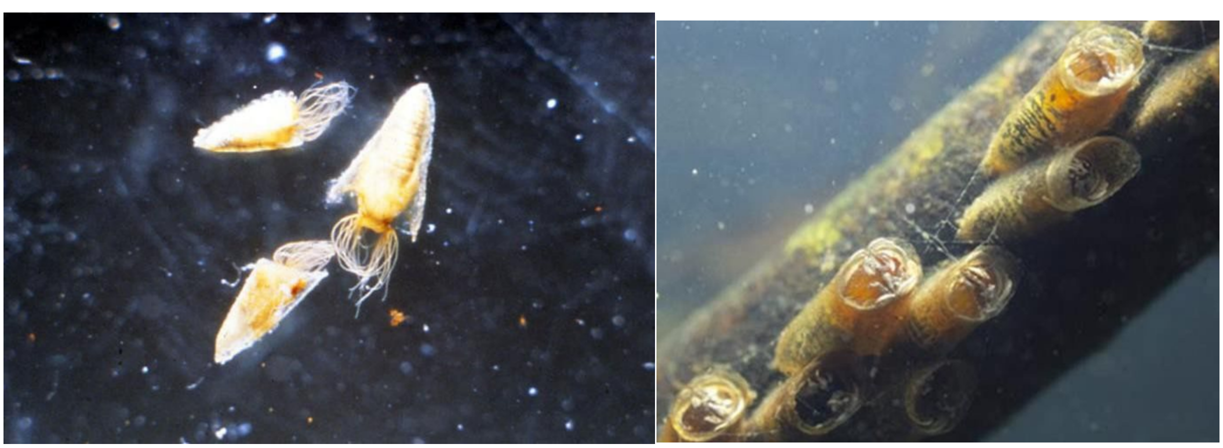


Figure 2: Pupae of blackfly

The adult is recognized by its wings, antennae and abdominal base. The wings are short and broad, and have tubular veins only toward the leading edge. Eye facets on the upper half of the head are larger than those on the lower half in the male but are the same in the female. The antennae are short and cylindrical, consisting of the scape, pedicel and 7–9 flagellar segments. The first abdominal segment is modified to form a prominent flange (Figure. 3).

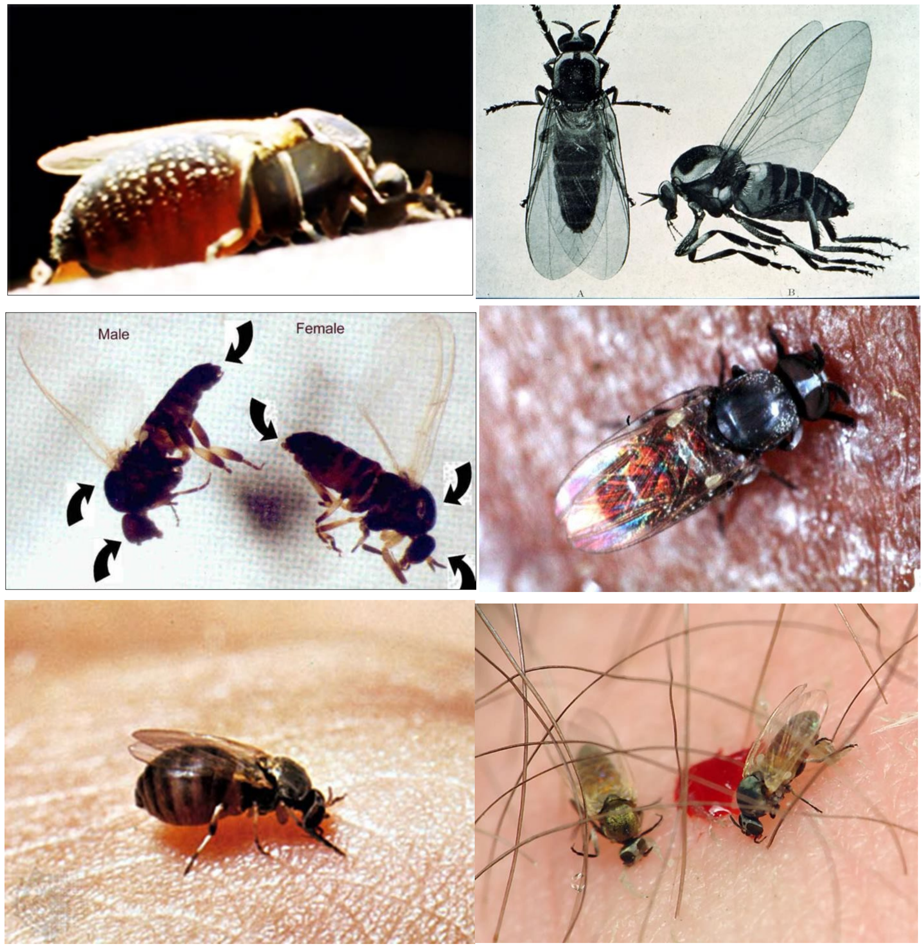


Figure 3: Adults of blackfly

Adults have special compound eyes (Figure.4)

Figure 4: special compound eyes in adults

Some species in Africa can range as far as 40 miles from aquatic breeding sites in search of their blood meals, while other species have more limited range. Fig. 6 show the breeding places of blakflies.

Figure 6: Breeding places of blackflies

There are several species of blackflies in the world including: *Simulium aestivum* Davies, Peterson et Wood, 1962, *Simulium albicinctum* (Enderlein, 1933), *Simulium albilineatum* (Enderlein, 1936), *Simulium albopictum* Lane et Porto, 1940, *Simulium alirioi* Perez et Vulcano, 1973, *Simulium amazonicum* Goeldi, 1905, *Simulium anamariae* Vulcano, 1962, *Simulium anatinum* Wood, 1963, *Simulium angrense* Pinto, 1931, *Simulium antillarum* Jennings, 1915, *Simulium antonii* Wygodzinsky, 1953, *Simulium antunesi* Lane et Porto, 1940, *Simulium aranti* Stone et Snoddy, *1969, Simulium arcticum* Malloch, 1914, *Simulium argentatum* Enderlein, 1936 *, Simulium argus* Williston, 1893, *Simulium aureum* Fries, 1824, *Simulium auripellitum* Enderlein, 1933, *Simulium auristriatum* Lutz, 1910, *Simulium baffinense* Twinn, 1936, *Simulium baiense* Pinto, 1931, *Simulium barbatipes* Enderlein, 1933, *Simulium beaupertuyi* Perez, Rassi, Ramirez, 1977*, Simulium bicoloratum* Malloch, 1913, *Simulium bicorne* Dorog., Rubtsov, et Vlasenko, 1935, *Simulium bivittatum* Malloch, 1914, *Simulium blancasi Wygodzinsky,* Coscaron, 1070, *Simulium bordai* Coscaron, Wygodzinsky, 1910, 1848, *Simulium botulibranchium* Lutz, 1910, *Simulium brachycladum* Lutz, Pinto, 1931, *Simulium bracteatum* Coquillett, 1898 , *Simulium brevifurcatum* Lutz, 1910, *Simulium caledonense* Adler et Currie, 1986, *Simulium callidum* Dyar et Shannon, 1927, *Simulium canadense* Hearle, 1932, *Simulium canonicola* (Dyar et Shannon, 1927)*, Simulium catarinense* Pinto, 1931, *Simulium cauchense* Floch, Abonnenc, 1946, *Simulium cerqueira* Almeida, 1974, *Simulium chalcocoma* Knab, 1914, *Simulium clarkei* Stone et Snoddy, 1969*, Simulium clarki* Fairchild, 1940,

Simulium clavibranchium Lutz, 1910*, Simulium congareenarum (*Dyar et Shannon, 1927*), Simulium conviti* Perez et Vulcano, 1973, *Simulium corbis* Twinn, 1936, *Simulium cormonsi* Wygodzinsky, 1971, *Simulium costaricense* Smart, 1944, *Simulium cotopaxi* Wygodzinsky et Coscaron, 1979, *Simulium craigi* Adler et Currie, 1986, *Simulium croxtoni* Nicholson et Mickel, 1950, *Simulium cuneatum* (Enderlein, 1936)*, Simulium decollectum* Adler et Currie, 1986, *Simulium decorum* Walker *Simulium defoliarti* Stone et Peterson, 1958, *Simulium dinellii* Joan, 1912, *Simulium diversibranchium* Lutz, 1910*, Simulium diversifurcatum* Lutz, 1910 *, Simulium dixiense* Stone et Snoddy, 1969*, Simulium downsi* Vargas, Palacio, Nayera, 1946*, Simulium duplex S*hewell et Fredeen, 1958, *Simulium dureti* Wygodzinsky, Coscaron, 1967, *Simulium ecuadoriense* Enderlein, 1934, *Simulium emarginatum* Davies, Peterson et Wood, 1962, *Simulium encisoi V*argas et Diaz Najera, 1949*, Simulium escomeli* Roubaud, 1909, *Simulium ethelae* Dalmat, 1950, *Simulium euryadminiculum* Davies, 1949, *Simulium excisum* Davies, Peterson et Wood, 1962, *Simulium exiguum* Roubaud, 1906, *Simulium fibrinflatum* Twinn, 1936 *, Simulium flavifemur* Enderlein, 1921*, Simulium flavipictum* Knab, 1914, *Simulium flavopubescens* Lutz, 1910*, Simulium fulvibnotum* Cerqueira et Mello, 1968, *Simulium furculatum* (Shewell, 1952)*, Simulium gabaldoni* Perez, 1971, *Simulium gaudeatum* Knab, 1914, *Simulium gaurani* Coscaron et Wygodzinsky, 1972, *Simulium giganteum* Rubtzov, 1940, *Simulium goeldi* Cerqueira et Mello, 1967 *Simulium gouldingi* Stone, 1952*, Simulium grerreroi* Perez, 1071, *Simulium griseum* Coquillett, 1898*, Simulium guianense* Wise, 1911, *Simulium guttatum (*Enderlein, 1936*), Simulium haematopotum* Malloch, 1914, *Simulium haematoptum* Malloch*, Simulium haysi* Stone et Snoddy, 1969, *Simulium herreri* Wygodzinsky et Coscaron, 1967*, Simulium hirtipupa* Lutz, 1910, *Simulium hoffmanni* Vargas, 1943, *Simulium hunteri* Malloch, 1914, *Simulium ignacioi* Perez et Vulcano, 1973, *Simulium ignescens* Roubaud, 1906, *Simulium impar Davies,* Peterson et Wood, 1962, *Simulium inaequale Paterson Ans* Shannon, 1927*, Simulium incertum* Lutz, 1910, *Simulium incrustatum* Lutz, 1910 *, Simulium inexorabile* Schrottky, 1909, *Simulium innocens (*Shewell, 1952*), Simulium iracouboense* Floch et Abonnenc, 1946, *Simulium itaunense* D'andretta et Gonzalez, 1964, *Simulium jacumbae* Dyar et Shannon, 1927, *Simulium jaimeramirezi* Wygodzinsky, 1971, *Simulium jenningsi* Malloch, 1914, *Simulium johannseni* Hart, 1912, *Simulium jonesi* Stone et Snoddy, 1969, *Simulium jujuyense* Paterson et Shannon , *Simulium acarayense* Coscaron, Wygodzinsky, 1972 , 1927, *Simulium jundiaiense* D'andretta et Gonzalez, 1964 , *Simulium kabanayense* Perez et Volcano,

1973, *Simulium lahillei* Paterson et Shannon, 1927, *Simulium lakei* Snoddy, 1976*, Simulium laneportoi* Vargas, 1941, *Simulium lassmanni* Vergas, Martinez, 1946, *Simulium laticalx* Enderlein, 1933*, Simulium latidigitus* Enderlein, 1936, *Simulium latipes* Meigen, 1804, *Simulium lewisi* Perez, 1971, *Simulium limbatum* Knab, 1915, *Simulium longistylatum* Shewell, 1959, *Simulium luggeri* Nicholson et Mickel, 1950 *, Simulium lurybayae* Smart, 1944, *Simulium lutzianum* Pinto, 1931*, Simulium machadoallisoni* Vulcano, 1981 *, Simulium major* Lane et Porto, 1940 , *Simulium malyschevi Dorog.,* Rubtsov, et Vlasenko, 1935*, Simulium manicatum* Enderlein, 1933, *Simulium maroniense* Floch et Abonnenc, 1946, *Simulium matteabranchia* Anduze, 1947, *Simulium mbarigui* Coscaron et Wygodzinsky, 1973, *Simulium mediovittatum* Knab, 1916, *Simulium meridionale* Riley, 1887*, Simulium meruoca* Mello, Almeida, Dellome, 1973, *Simulium metallicum* Bellardi, 1859, Hagen, 1880, *Simulium mexicanum* Bellardi, 1862, *Simulium minus* (Dyar et Shannon, 1927)*, Simulium minusculum* Lutz *, Simulium morae* Perez, Rassi, Ramirez, 1977, *Simulium mutucuna* Mello et Silva, 1974, *Simulium nebulosum* Currie et Adler, 1986, *Simulium nigricoxum* Stone, 1050*, Simulium nogueirai* D'andretta et Gonzalez, 1964, *Simulium notatum* Adams, 1904, *Simulium notiale* Stone et Snoddy, 1969, *Simulium nunestovari* Perez, Rassi, et Ramirez, 1977, *Simulium nyssa* Stone et Snoddy, 1969, *Simulium obesum* Vulcano, 1959, *Simulium ochraceum* Walker, 1861, *Simulium opalinifrons* Enderlein, 1934, *Simulium orbitale* Lutz, 1910, *Simulium* ortizi Perez, 1971, *Simulium oviedoi* Perez, 1971, *Simulium oyapockense* Floch et Abonnenc, 1946 *, Simulium paraguayense* Schrottky, 1909, *Simulium paranense* Schrottky, 1909, *Simulium parnassum* Malloch, 1914 , *Simulium paynei* Vargas, 1942, *Simulium penobscotensis* Snoddy et Bauer, 1978, *Simulium perflavum* Roubaud, 1906, *Simulium pertinax* Kollar, 1832*, Simulium petersoni* Stone et Defoliart, 1959, *Simulium pictipes, Simulium pilosum* (Knowlton et Rowe, 1934), *Simulium pintoi* D'andretta et D'andretta, 1946*, Simulium piperi* Dyar et Shannon, 1927, *Simulium podostemi* Snoddy, 1971, *Simulium prodexargenteum (*Enderlein, 1936*), Simulium pruinosum* Lutz, 1910, *Simulium pseudoexiguum* Mello et Almeida, 1974, *Simulium pugetense (*Dyar et Shannon, 1927*), Simulium pulverulentum* Knab,
1914 *,Simulium quadrifidum* Lutz, 1917, *Simulium quadristrigatum* Enderlein, 1933, *Simulium quadrivittatum* Loew*, Simulium quebecense* Twinn, 1936, *Simulium racenisi* Perez, 1971, *Simulium rangeli* Perez, 1977, *Simulium rivasi* Perez, 1971*, Simulium rivuli* Twinn, 1936*, Simulium rorotaense* Floch et Abonnenc, 1946, *Simulium rubiginosum* Enderlein, 1933, *Simulium rubrithorax* Lutz, 1909,

Simulium rubtzovi Smart, 1945, *Simulium rugglesi* Nicholson et Mickel, 1950, *Simulium samboni* Jennings, 1915*, Simulium sanguineum* Knab, 1915, *Simulium schmidtmummi* Wygodzinsky, 1973, *Simulium scutistriatum* Lutz, 1909, *Simulium seriatum* Knab, 1914 Stone et Snoddy *Simulium sicuani* Smart, 1944, *Simulium simplicicolor* Lutz, 1910, *Simulium slossonae* Dyar et Shannon, 1927, *Simulium snowi* Stone et Snoddy, 1969, *Simulium solarii* Stone, 1948*, Simulium spadicidorsum* (Enderlein, 1934*), Simulium spinibranchium* Lutz, 1910, *Simulium spinifer* Knab, 1914, *Simulium strigatum (Enderlein, 1933), Simulium strigidorsum* (Enderlein, 1933)*, Simulium striginotum* (Enderlein, 1933)*, Simulium suarezi Perez,* Rassi et Ramirez, 1977, *Simulium subclavibranchium* Lutz, 1910, *Simulium subnigrum* Lutz, 1910, *Simulium subpallidum* Lutz, 1910*, Simulium tallaferroae* Perez, 1971, *Simulium tarsale* Williston, 1896, *Simulium tarsatum* Macquart, 1847, *Simulium taxodium* Snoddy et Beshear, 1968, *Simulium tescorum* Stone et Boreham, 1965, *Simulium townsendi* Malloch, 1912, *Simulium transiens* Rubtzov, 1940, *Simulium travassosi* D'andretta et D'andretta, 1947, *Simulium trivittatum* Malloch, 1914, *Simulium truncata* (Lundstrom, 1911), *Simulium tuberosum (*Lundstrom, 1911), *Simulium underhilli Simulium pifanoi* Perez, 1971, 1969, *Simulium urubambanum* Enderlein, 1933*, Simulium varians* Lutz, 1909, *Simulium venator* Dyar et Shannon, 1927*, Simulium venustum* Say, 1823, *Simulium verecundum* Stone et Jamnback, 1955, *Simulium vernum* (Macquart, 1826)*, Simulium versicolor* Lutz et Tovar, 1928, *Simulium violacescens* Enderlein, 1933, *Simulium virgatum* Coquillett, 1902, *Simulium vittatum (Zetterstedt, 1838), Simulium wuayaraka* Ortiz, 1957, *Simulium wyomingense* (Stone et De Foliart, 1959), *Simulium yacuchuspi* Wygodzinsky et Coscaron, 1967.

Methods

In this research all, the relevant information regarding the topic of research is research through the internet and used in this paper. An intensive search of scientific literature was done in "PubMed", "Web of Knowledge", "Scopus", "Google Scholar", "SID", etc.

Results and Discussion

Medical Importance of blackflies

The black fly is central to the transmission of the parasitic nematode *Onchocerca volvulus,* which causes Onchocerciasis, also known as river blindness. It serves as the larval host for the nematode and acts as the vector by which the disease is spread. Transmission of the parasite

occurs through the bite of a black fly when feeding on human blood. Fishermen, farmers and loggers are frequently bitten by the black flies that transmit onchocerciasis. Figure. 7 shows the world distribution of Onchocerciasis (river blindness). The disease is endemic across equatorial Africa where an estimated 99% of those infected live, and in certain areas of Central and South America. Up to 86 million are at risk of acquiring infection, and an estimated 600,000 people are visually impaired by the disease, with half of them partially or totally blind. In hyper endemic areas, infection rates approach 100%, and over a lifetime, 50% of the population will be blinded by the disease.

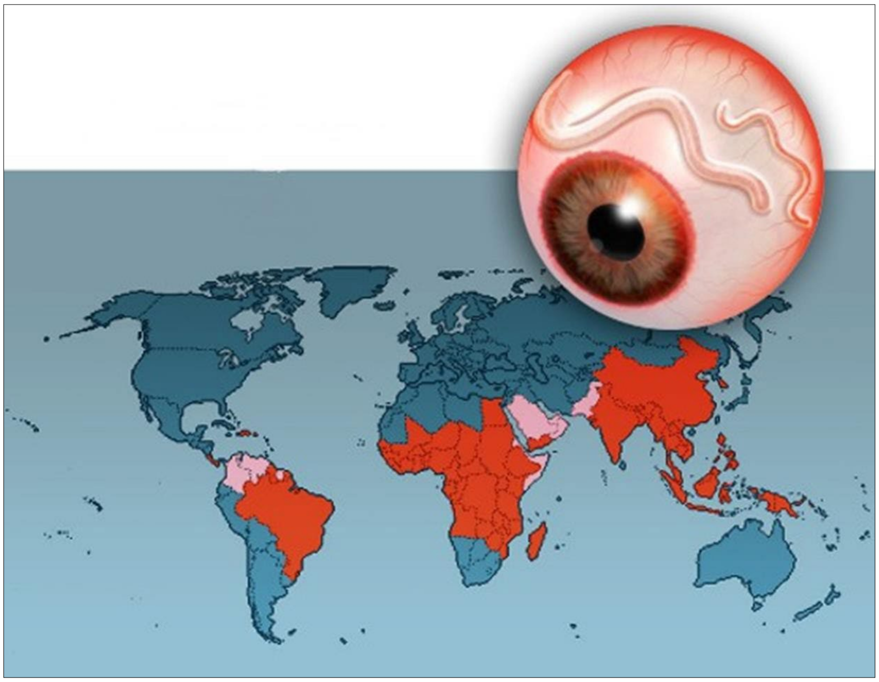


Figure 7: world distribution of Onchocerciasis (river blindness)

Onchocerciasis is caused by O. volvulus (Figure.8,9) , a parasitic worm that lives for up to 14 years in the human body. Each adult female worm, thin but more than 1/2 meter in length, produces millions of microfilariae (microscopic larvae) that migrate throughout the body and give rise to a variety of symptoms: serious visual impairment, including blindness; rashes, lesions, intense itching and depigmentation of the skin; lymphadenitis, which results in hanging groins and elephantiasis of the genitals; and general debilitation. Onchocerciasis manifestations begin to occur in persons one to three years after the injection of infective larvae. Within the human body, the adult female worm (macrofilaria) produces thousands of baby or larval worms (microfilariae) which migrate in the skin and the eye (Figure.10). In the human host, adult worms can live for 15 years in the human body. The male and female worms enter in nodules in the subcutaneous tissue of the skin. After mating, the female worm releases around 1000 microfilariae larvae a day into the surrounding tissue. Microfilariae live for 1–2 years, moving around the body in the subcutaneous tissue. When they die, they cause an inflammatory response that leads to skin rashes, lesions, intense itching and skin depigmentation. Microfilariae also migrate to the eye, where they cause inflammation and other complications that can lead to blindness.

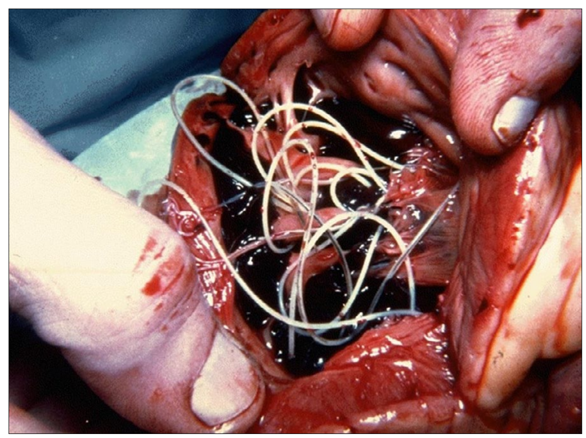


Figure 8: ***Onchocerca volvulus*** **, the agent of river blindness.**

Figure 9: ***Onchocerca volvulus:*** **nodules (removed from under the skin of infected people) contain the adult worms.**

Figure 10: symptoms of river blindness

Patient infected with *Onchocerca volvulus.* The parasite which causes onchocerciasis (river blindness). This elderly man shows nodules, skin changes and blindness, all manifestations of the disease (Fig.11) (1-3).

Figure 11: Manifestations of the disease

Drug Treatment: The development of ivermectin in the 1980s provided a safe, effective drug for killing microfilariae in infected people. Diethylcarbamazine (DEC) only kills microfilaria. Ivermectine (Mectizan®) (150 microgram/kg single dose) only kills microfilaria .Suramin only kills macrofilaria.

Vector Control: The insecticide is introduced into rivers and streams in several places. The number of application points should be determined from a preliminary survey and will vary by area and river according to the insecticide formulation used, the breeding habits of the local vector and the characteristics of the watercourse, such as flow rate. In the area covered by the Onchocerciasis Control Programme, temephos was initially the preferred larvicide because of its effectiveness, the distance down river from the application point at which it remains effective and its relative safety for non-target fauna. The appearance of resistance in West Africa in 1980, however, required adoption of a strategy in which insecticides with other modes of action were used alternately, to stop further development and spread of resistance and to forestall the appearance of new cases of resistance. This strategy of rotation of insecticides proved effective during the 15 years in which it was implemented. B. *thuringiensis* H-14 is used at relatively high doses and has a short distance of effectiveness. Nevertheless, it was the main larvicide used during the last 10–15 years of the Onchocerciasis various larvicides can be applied including *Bacillus thuringiensis,* Carbosulf, Phoxim, Pyraclofos, Temephos, Permethrin and Etofenprox. Generally, *B, thuringiensis* H-14 is the preferred larvicide. In areas where there is no resistance, this product can be supplemented by temephos, especially when river discharges are relatively high and cannot be measured precisely for the proper dosage of the insecticide. There are several reports of drug and insecticide resistance in the agent and vectors of disease worldwide [1-21].

Conclusion

Results showed ivermectin as drug resistance in agent (*Onchocerca volvulus*) and a wide variety of susceptibility/resistance status of *Simulium domnosum* to insecticides in the world. Due to the importance of these species in the transmission of diseases, resistance management strategies should be further considered to prevent insecticide resistance and replacement of novel approaches for vector control [22-53].

Conflict of interest

The author declare that there is no conflict of interest.

Acknowledgments

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