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REVIEW

Dragonflies as an Important Aquatic Predator Insect and Their Potential for Control of Vectors of Different Diseases

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ABSTRACT

Mosquitoes belong to order of Diptera. The main important vectors are genus *Aedes, Culex* and *Anopheles*. They transmit different agents such bacteria, viruses, and parasites. According to the latest information around 7 hundred million people around the world are suffering from mosquito-borne illness resulting over one million deaths. The main important disease transmitted by Anopheles is malaria. Other genus of mosquitoes including *Aedes* and *Culex* species transmit different arboviral disease to human. According to guideline of World Health Organization, the mina control of disease is vectors control. The main important vector control is using different insecticides. Using chemical insecticides for controlling mosquitoes is limited because they develop resistance against these insecticides. So, efforts have been made to control the mosquito vectors by eco-friendly techniques. 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 shows that one of important environmental friendly vector control is biological control, using different predators and other microorganisms for vector and pest control. Dragonflies do eat mosquitos and serve as mosquito predators. They feed on mosquitos and reduce their number in outdoor areas. The dragonflies are scary biters, but they are dangerous to mosquitos. Worldwide results showed that dragonflies are able to control *Aedes, Culex* and Anopheles mosquito species. The artificial rearing of these predators and releasing for biological control is an appropriate measure for vector control worldwide.

1. Background

Dragonflies have sharp teeth on the jaws. According to the latest information a total of 7,000 species have been reported. Both nymphs and adult stages are predators of mosquitoes. The adults of dragonflies are scooping the mosquitoes by their legs and eat from them. They fly on sunny and warm days near fresh water (Figure 1). There are some reports indicating that nymph could survive for 5 years. Life span of adult stage varied and depend on species of insects. Dragonflies comprise ten families among which

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the Libellulidae, with 140 genera and about 962 species is the largest. This cosmopolitan family, considered to be the family of most recent origin, contains about a quarter of the known species of living Odonata. Dragonflies migrate from different parts of the world to complete the migration. They are known as farthest migrations of all insect species. The dragonfly's speed and agility contribute to its being one of the most effective aerial predators. Dragonflies included several families including Corduliidae, Aeshnidae, Libellulidae, Cordulegastridae, and Gomphidae. The adult dragonflies eat insects especially mosquitos and control their population. Each adult dragonfly feeds upon hundreds of mosquitos within a day. The adult dragonflies can feed on all the insects by using their legs that form the basket to clutch their prey into a slushy mess. These dragonflies then use their mandibles for swallowing the creatures. The adult dragonflies catch the insects during their flight and feed on gnats, mosquitos, mayflies, moths, bees, ants, termites, butterflies and other flying insects. They fly up and down in the air like a helicopter. The mosquitos are the bulk component of their diet. The larger the size of a dragonfly, the larger the prey it will catch. They can consume large prey and eat 15% diet equal to their body weight. The dragonflies eat various mosquitos each day. The nymphs feed on mosquito larvae when in water. The larvae stage of mosquitos is the better predator of mosquitos. The adult dragonflies feed on insects during the daytime when the mosquitos keep hiding in the bushes or timberlines. The adult dragonflies feed on adult mosquitos while basking themselves in sun and sitting on flat rocks.

Nymph usually capture the prey by extending the mouthparts (Figure 2). The nymphal stage is 9-17. Different species of odonate have different nymphal stages. In dry condition they have one generation, while in tropical situation they have multiple generations and those depend on habitat situations. At the nymph stage, they suck the water into their abdomen and then spitting it out. Nymphs usually absorb oxygen by their gills from the water. In the abdomen they draw water in and pump it out again through the anus. The have around 6-15 nymphal stages. Adults which hunt the mosquitos, and midges live about a month. Their legs could catch the mosquitoes and scoop up prey in flight. These insects live in the conditions with stable oxygen levels and clean water. They are considered as bioindicators for environment as well as ecosystem and health. Dragonfly nymph could act as sprawlers, burrowers, hiders, or claspers. Microhabitat they occupy effect on the shape, metabolism, and respiration.

There are some reports indicating that dragonflies fossils belong to the Carboniferous period. They show a wingspans of over one meter and look like a modern hawk (Figure 3).

a

b

c

d

Figure 1. Adults of dragonfly a) Darner Family b) Emerald Family c) Skimmer Family d) Clubtail Family

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Figure 2. Nymphal stage of dragonfly a) nymphal stage of different families b) mouthparts of nymph c) eyes of nymph (Google search)

Figure 3. dragonfly fossil (Google search)

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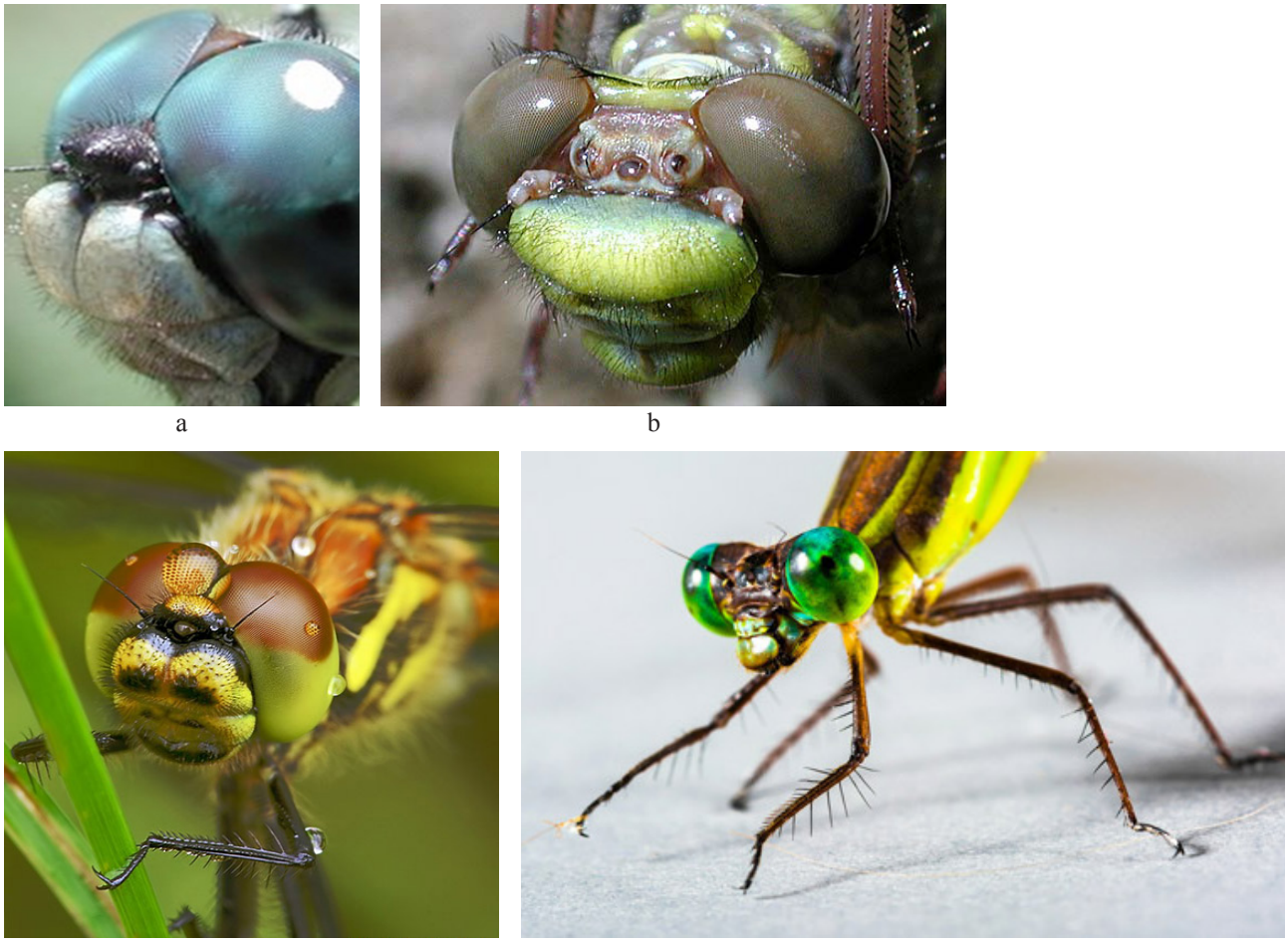
Dragonfly at the adult stage has bristle-like shape. They have large compounds eyes which cover most of the head. They have four membranous wings include veins and cross veins. On the wings they have pigment cell which is important for their identification. Base of hind wing broader than forewing. Their abdomen is long and slender. Their compound eyes are very big and have appropriate and excellent eyesight due to their eye structure. A total of 30,000 facets have been recorded from their compound eyes. Each of facets is a separate light-sensing organ which is called ommatidium. The can see nearly a 360° field of vision (Figure 4).

Males of many of dragonflies are considered as territorial. They have responsibility to defend the territory against other creatures even other species of dragonflies. After laying eggs by females, the males normally set up a territory. The used their good oviposition for defending the breeding places from other males and challenge other dragonfly species and other animals (Figure 5). The mating wheel form is shown in dragonflies when they mate. They have second sexual organ which is located in the second parts of their abdomen. The wheel is formed when the male grasps the female behind the head and the female raises the tip of her abdomen forward to come in contact with the secondary genitalia of the male. Odonates are able to fly in tandem form. The adults dragonfly of dragonflies is around 6 to 8 weeks during the summer. Adults appear to be constantly hunting. Prey is scooped out of the air and consumed in flight. Dragonflies can consume too many and large numbers of mosquitoes. Most dragonflies are regarded as beneficial insects because they feed on small flying insects such as mosquitoes. The main predators of dragonflies are: birds, amphibians, spiders, wasps, lizards, small rodents, other odonata, adults of ceratopogonoidae, carnivorous plants like sundew.

Figures 6-9 show the global distribution of mosquitoes in the world. From these figures it should be concluded



a b

b

Figure 4. Compound eyes of adults of dragonfly a) compound eye, b) ommatidium of compound eye (Google search)

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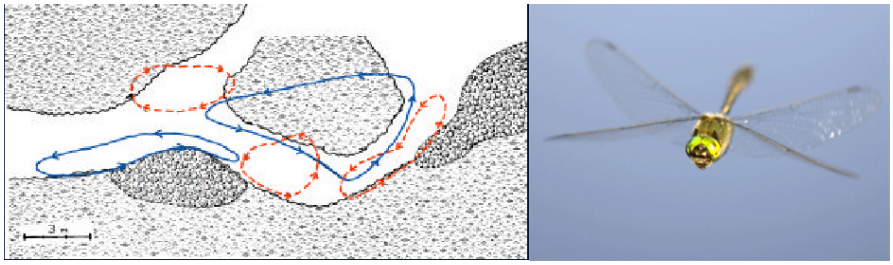

a b

Figure 5. Territory of Male dragonfly to protect the laid eggs by female a) male dragonfly territories over breeding site b) flying of male over territory (Google search)

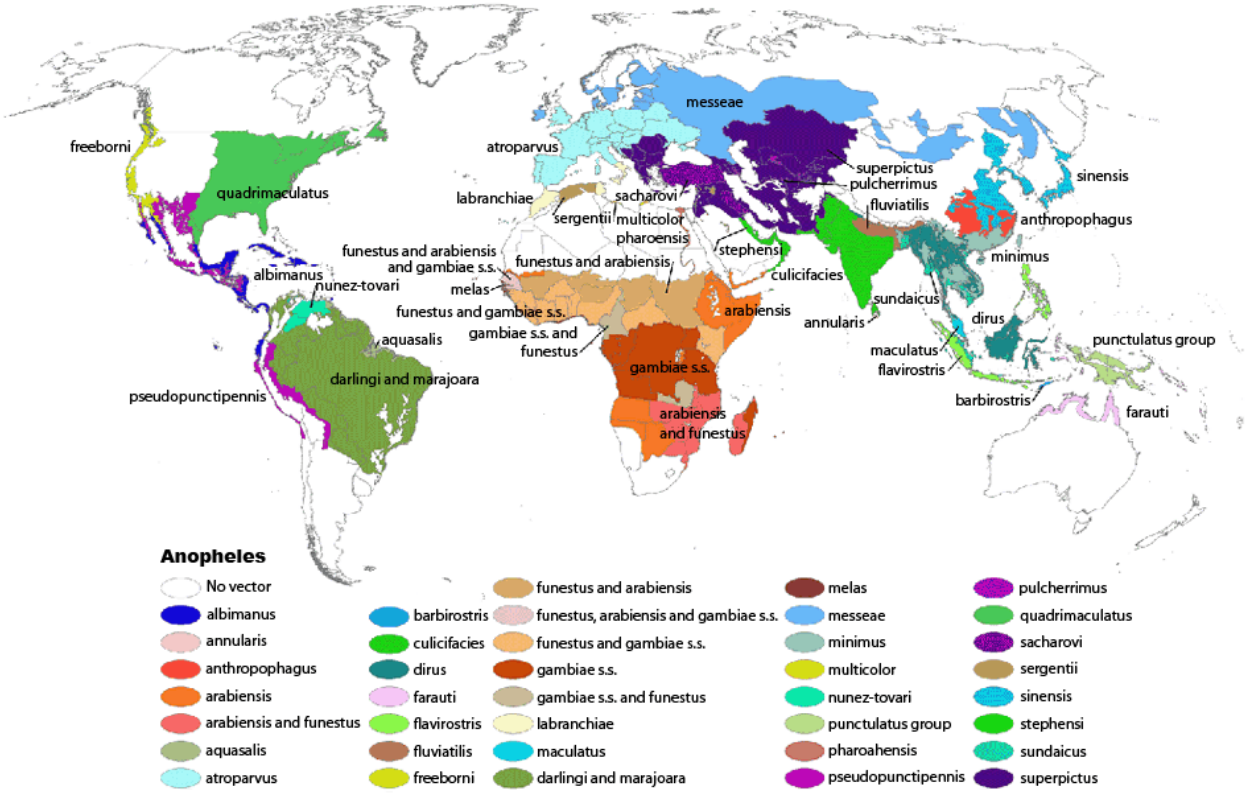

Figure 6. Global map of Anopheles species as the vector of malaria (Google search)

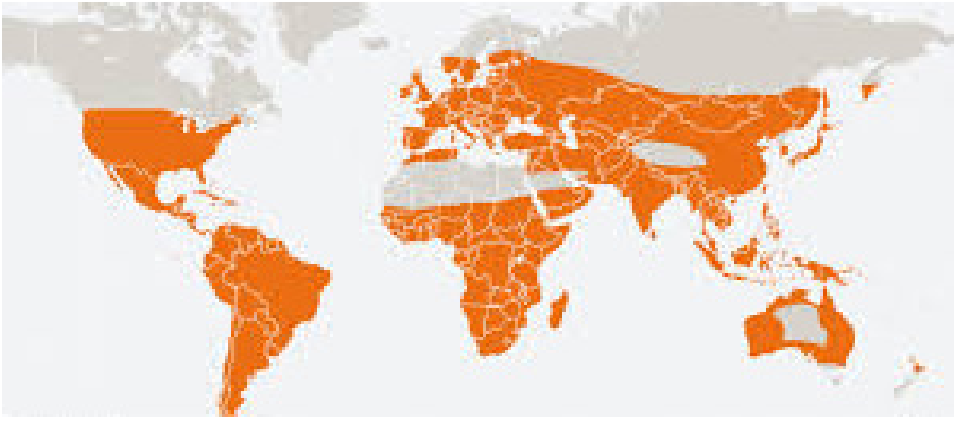

Figure 7. Global distribution of Culex mosquitoes (Google search)

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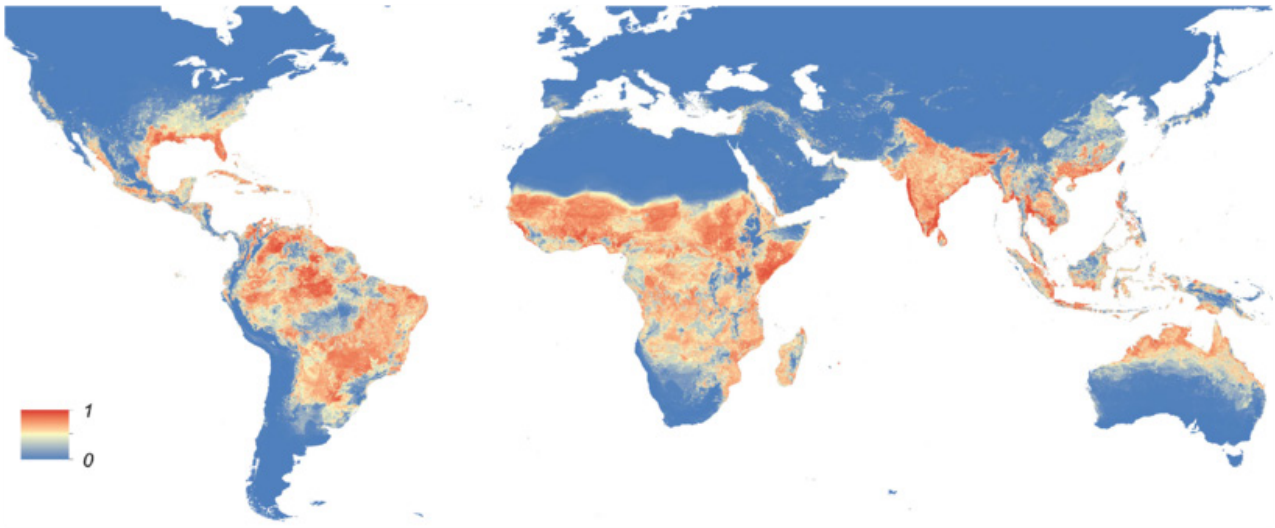

Figure 8. Global distribution of *Aedes aegypti* mosquito (Google search)

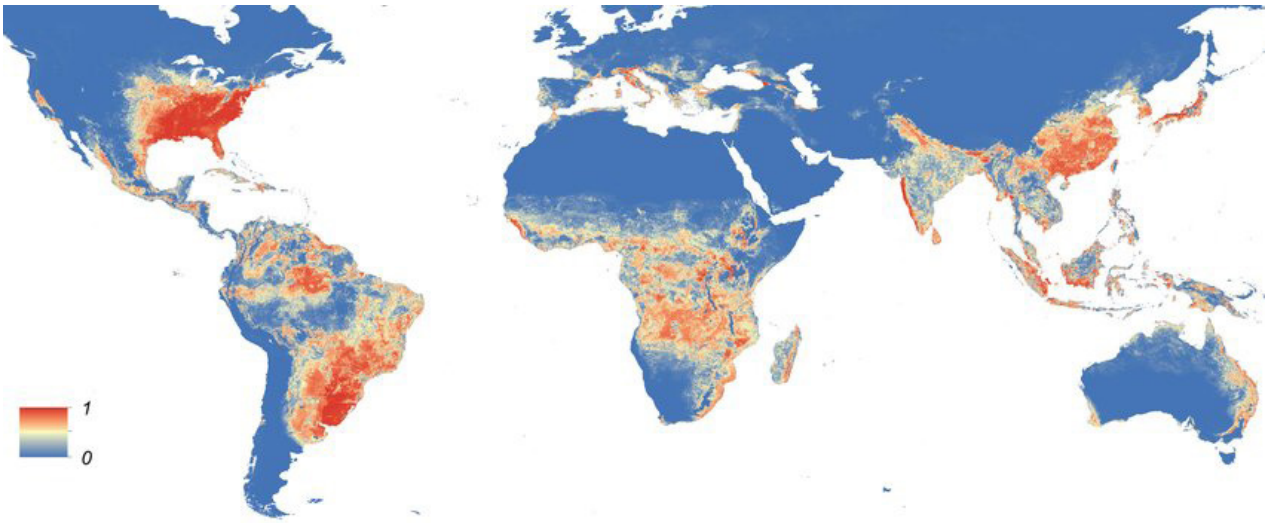

Figure 9. Global distribution of *Aedes albopictus* mosquito(Google search)

that nearly main parts of the world are mainly important breeding places of the mosquito, so that people are at risk of mosquito-borne diseases. According to the report of World Health Organization, more than half populations of the world are at risk of vector-borne diseases.

2. 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.

3. Results and Discussion

There are several reports on efficacy of dragonfly for control of mosquitoes [1-15]. In a study odonata nymphs have been releases for control of vector of dengue diseases, *Aedes aegypti.* The release of this dragonfly reduced the mosquito larval production and thereby control dengue epidemics. Due to high longevity of odanata, their predatory habitats, trophic position and laying eggs in mosquito habitats at the immature stages are important factors for biological control of mosquitoes. Mandal *et al*., (2008) [2] used the five Odonate species in semi field conditions. They observed significantly reduction of mosquito larval density after 15 days of introduction. In West Benga. Similarly, the nympha of 5 odonate species *Aeshna flavifrons*, *Coenagrion kashmirum*, *Ischnura forcipata, Rhinocypha ignipennis* and *Sympetrum durum* in were evaluated in West Bengal,

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India under the semifield conditions. Results showed, the mosquito density after 15 days of introduction reduced (Mandal et al., 2008). They suggested use of odonate nymph for reducing in the breeding places of mosquitoes reduced the larval population. They could be releases in the temporary pools or larger habitats, where they can be a potential biological resource in regulating the larval population of the vector and pest mosquitoes. In another study, the efficacy of the dragonfly nymphs on dengue vector. *Aedes aegypti* were studied under laboratory and field conditions. The results showed that Nymphs act as predator against larvae and pupae of species *Ae. aegypti*. Complete elimination of immature stage of mosquitoes were achieved between day 4 and 9, depending on density of aquatic stages. In container habitats. Sebastian *et al*. (1980) [15] found that dragonfly nymph calling*, Labellula sp.,* eliminate *all aquatic stage of Ae. aegypti* larvae and pupae in day 4 and 9. They suggested the use of this predators for biological control of *Aedes* mosquitoes. Sebastian *et al*. (1990) [16] conducted a pilot field study. They released nymph of a dragonfly for suppressing *Ae. aegypti* population during the rainy season in Yangon, Myanmar. The results showed reduction of larval population of *Ae. aegypti* in 2 to 3 weeks. The predator suppressed the population of mosquito until the end of trial. The reduction of adult mosquito population was also observed after about 6 weeks. The study was carried out by Chatterjee et al. (2007) [17]. They used dragonflies for control of malaria vector, *Anopheles subpictus* in concrete tanks under field conditions in India. Results showed a significant decrease in *Anopheles subpictus* larval density in dipper samples after 15 days of introduction of dragonfly nymph.

4. Conclusions

More than half populations of the world are at risk of vector-borne diseases. Nearly all parts of the world are favorite breeding places for mosquitoes. According to these results, it is shown that the Odanata species are able to control of *Anopheles, Aedes* and *Culex* species of mosquitoes at the adult and larval stages. These mosquito species are the main important vectors of disease to human. Due to insecticide resistance of the vectors to different insecticides, the using of biological control is an appropriate as Integrated Vector Management program. Therefore, artificial rearing of this predator insects and releasing of them in the mosquito-borne diseases area could reduce the mosquito-borne diseases.

Conflict of interest

The author declare that there is no conflict of interest.

Acknowledgments

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