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Research Article

Malaria Vector Mosquitoes and Their Relationship with Human Life Activities in Hindupur Mandal, Andhra Pradesh, India

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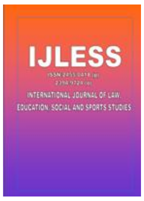

ABSTRACT
Mosquitoes are living organisms that are spread throughout the world, most of which can be detrimental to human life because they spread infectious diseases (vector-borne diseases), including malaria, dengue fever, encephalitis, filaria, and chikungunya. Not all female mosquito species can act as disease transmitters; only a few include the Anopheles, Culex, Aedes, and *Mansonia* genera. Important diseases that these four genera can transmit are malaria, filaria, dengue fever, and Japanese encephalitis. This paper examines how *Anopheles* mosquitoes can cause public health problems and their distribution to human activities in Hindupur mandal (13.8300°N; 77.4900°E) villages, Andhra Pradesh, India. Various human activities can contribute to breeding places for mosquitoes if these places are not well maintained/controlled. This will be detrimental to humans because the mosquito population increases, providing opportunities for mosquito bites to come into contact with humans. Certain mosquito vector species are closely related to human activities, from managing rice fields, fish ponds, plantations, animal husbandry, and storing water to disposing of household wastewater, providing opportunities for mosquitoes to breed. In general, malaria vectors in Hindupur Mandal, Andhra Pradesh, India, have zoophilic and slightly anthropophilic behavioral characteristics, which are different in each endemic area and are emphatic and exophilic, which are also different as an entomological parameter of health.
Key words: Mosquitoes, infectious diseases, Anopheles, human life activities

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Introduction

Mosquitoes are living organisms that are found abundantly in nature almost everywhere. They are considered detrimental because their bites disrupt human life, namely causing dermatitis and transmitting various diseases. Mosquito species that can transmit disease include the *Anopheles, Culex, Aedes and Mansonia* genera which transmit malaria, filaria, dengue fever, Japanese encephalitis and others [1]

Mosquito type *Anopheles sundaicus*, *Anopheles subpictus*, *Anopheles farauiti* transmits malaria in coastal areas; *Anopheles* maculatus and *Anopheles Aconitus* in mountainous areas. The mosquito *Ae.*

aegypti and *Ae.albopictus* play a role in transmitting dengue hemorrhagic fever, *Culex quinquefasiatus* mosquitoes transmits filaria caused by the worm *Wucheria brancrofti* in urban areas and *Anopheles vagus*, *Anopheles Aconitus*, *Anophelessubpictus* in the countryside. Mansonia uniformis and *Anopheles* spp transmit *Brugria* sp, *Culex mosquitoes*. *vishnui, Culex tritaeniorhyn- chus, Culex. gelidus* acts as a vector for Japanese henchephalitis (inflammation of the brain), the *Ae. albopictus* as a Chikungunya vector, *Toxorhynchitis* mosquitoes as a biological control for mosquito larvae [2].

When a female mosquito sucks the blood of a malaria or dengue sufferer, it carries Plasmodium and the Dengue virus in human blood. Mosquitoes that have sucked the blood of sick people will be infected by Plasmodium or viruses, which then occurs in the mosquito's body. Research and Development Center for Ecology and Health Status, Vijayawada, Andhra Pradesh, India, life cycle of parasites and viruses. If an infected mosquito bites a healthy person, the malaria parasite or virus will enter the human blood, then the healthy person will become sick [3]. In the human body there is a life cycle of the malaria parasite (asexual) to reproduce itself.

Mosquitoes can breed well if the environment suits their needs. Human interests in managing agricultural land, fisheries, plantations, animal husbandry will be used for the breeding of mosquito larvae, thereby influencing the density and behavior of mosquitoes in a place [4].

The spread of malaria is determined by several factors including agent, host (host) and the environment which interact with each other. The agent (parasite) lives in the human body (intermediate) and the mosquito body (definitive). In the mosquito's body the agent develops into an infective form, ready to transmit to humans who function as intermediate hosts who can become infected and become a place for the agent to develop [5].

Mosquito bioecology of anopheles

The adult Anopheles mosquito measures 0.413 cm with a body that appears fragile but has a body structure and function that is strengthened by a strong exo-skeleton and endoskeleton to protect the soft internal organs [6]. Complete organs and systems for life like humans, namely muscles, respiration, circulation, excretion, nerves, digestion, senses and reproduction (ovaries are very soft). The complete organs and systems for life are the same as in humans, including nerves, muscle digestion, excretion, circulation, respiration, reproductive organs and senses. The pre-adult stage of mosquitoes carries out life activities and develops in water. Mosquitoes have a life cycle through four stages, namely egg, larva, pupa and adult mosquito stages. So mosquitoes are grouped into the completely metamorphosed insect group. The egg, larva and pupa stages of this mosquito live and reproduce in water. The egg stage measures 6 mm in length and 1.25 mm in width, with a float on the side, hatches after 12 days under normal conditions.

Mosquito eggs range from 100 to 300 eggs (an average of 150 eggs per egg) then hatch into larvae which undergo development (4 instars) for 4 to 8 days. Then it develops into a pupa, for 2-3 days and becomes an adult. Female Anopheles mosquitoes have an average lifespan of 25.6 days, especially female Anopheles mosquitoes can reach an age of 8-41 days with an average of 24 days. Both male and female mosquitoes can survive for about 25 days: 50% of male mosquitoes live more than 13 days and female mosquitoes more than 12 days 2.

Mosquito life table [7] *Anopheles aconitus* shows that the average life period of a population in one generation is (T=9.86), a constant which expresses reproductive potential (Rm=1.93), as well as a quantity which shows the ability of a population in one generation to reproduce itself per unit of time (á.=0.29). Compared with the population in one generation *Anopheles* farauti which reached 9.86, population *Anopheles aconitus* develops very slowly. This difference can change the rate of population increase because it is based on a shorter T value in *Anopheles farauti,* has increased the Ro value, namely 13250.36 individuals, while in *Anopheles aconitus* it is only 545.83 individuals. The reproductive potential constant of a population in one generation (Rm) in *Anopheles farauti* is 4.12 while in *Anopheles aconitus* it reaches Rm=1.95 and the ability of the population in one generation to reproduce itself per unit of time in the two species shows differences.

Female Anopheles mosquitoes bite humans or animals to develop their eggs and actively search for food at night from 18.00 to 6.00 in the morning, with peak bites for each species being different.[8] *Anopheles aconitus* bites peak at 22-23 then decrease and increase again at 0102 midnight6. In India, Central Gujarat *Anopheles Aconitus* starts biting at 18.00 with peak bites at 2.00 midnight8. An's blood search activity. barbirostris is throughout the night, most at 23.00-05.00, *Anopheles sundaicus* most at 22.00-23.00, *Anopheles* Most maculatus at 21.00-03.00 are mostly caught outside the house.

Exophagic mosquitoes are mosquitoes that mostly bite outside the house, but can enter the house if humans are the main host, for example *Anopheles balabacensis*, *Anopheles sinensis*, *Anopheles Aconitus*. Endophagic mosquitoes are mosquitoes that bite inside the house, but if a host is not available in the house some mosquitoes will look for a host outside the house.

Estimating the age of mosquitoes (relative age) in nature is an important factor in determining vector incrimination so that transmission can be detected which causes the high and low number of cases in a place, which can be determined by dissecting the ovaries and calculating the length of the gonotrophic cycle [9]. Mosquitoes move from breeding places to resting places and then to hosts depending on their flying ability. In general, mosquitoes are able to fly as far as 350-550 meters, for example *Anopheles* sinensis flight distance reaches 200 to 800 meters, *Anopheles barbirostris* reaches 200 to 300 meters; but from the results of several studies, there are mosquitoes that can reach 1 – 2 km.

Population dynamics is a description of the fluctuations in the mosquito population over time, measured by the density of mosquitoes in a place. For example, the population dynamics of *Anopheles Aconitus* in Chowlur village of Hindupur mandal,[10] there are two peaks in a year, namely between March-April and between August-September. In Sreekanthapuram (R) village, the peak population density of *Anophelesaconitus* is in July both inside and outside the house, while in Hinduri village the peak population density of *Anopheles aconitus* is in July and December. Fluctuations in the density of mosquitoes resting on the walls inside the house in Thumukunta village, highest in December and around the enclosure highest in October. Peak population density *Anopheles Aconitus* in some areas does not occur at the same time because it depends on the pattern of planting and harvest times. In Central Gujarat, the peak population density of *Anopheles Aconitus* in June and July. *Anophelessundaicus* in fish pond areas is generally high in June-July, while at river estuaries and lagoons it is high in September-October[11].

Mosquito *Anopheles Aconitus* is found resting in the house both day and night in small quantities. During the day *Anopheles Aconitus* is found in abundance on river cliffs. From research in Andhra Pradesh, India, it shows the activities of *Anopheles Aconitus* occurred during the day because 5% of them were caught inside the house, while the other 34% were caught from cages with walls inside the house; during the day, *Anopheles Aconitus* is more dominant than other species. Resting place, the most common *Anopheles aconitus* found was in ditch cliffs, namely 61% of all mosquitoes collected17. This incident was seen from 32,056 Anopheles mosquitoes that *Anopheles barbirostris* was caught with a composition of 70% *Anopheles Aconitus*, 23.4% *Anopheles indefinitus* and 6.6% of other Anopheles species consisting of *Anopheles barbirostris* and *Anopheles vagus*. In Satyasai district, *Anopheles Aconitus* caught in nature or outside the house in the morning was an average of 48.2%, in cages 5.5% and inside the house 2%.

Mosquito connection with human activities

On managed land, for example rice fields, various types of mosquitoes are usually inhabited, whether they act as vectors or not. India is an agricultural country that has rice fields in the lowlands and mountains, making it suitable for the development of various types of mosquitoes. In the rice fields near the coast, 33 species have been found, consisting of 10 types of *Anopheles,* 5 of which play a role in transmitting malaria, 13 types of *Culex*, 4 types of *Aedes,* the rest are *Mansonia* and *Ficalbia*. Rice fields with rice plants are confirmed to have *Anopheles Aconitus*, *Culex* t*ritaeniorhyncus*, *Anopheles indefinitus* and *Anopheles anullaris*. In the dry season, mosquitoes migrate to hill areas to continue their lives, and during the rainy season, when farmers cultivate rice fields, mosquitoes will breed again [12].

Plants in plantation areas are very influential on the lives of mosquitoes, including as a place to lay their eggs in tree holes, as a shelter, as a place to find food and shelter. For example, snake fruit plantations with irrigation will become a breeding ground for mosquitoes. *Anopheles bala- basensis*. Shrimp and fish ponds that are neglected or not managed properly can become breeding grounds for several species of mosquitoes. Because the pond is filled with grass and moss, it can be used as a breeding place for *Anopheles subpictus*; lagoons with silk moss and chicken belly moss are suitable for *Anophelessundaicus*; These two types of mosquitoes act as malaria vectors in coastal blood.

Areas of sago plants in swamp areas with floating aquatic plants are suitable for breeding *Ma.uniformis*; Swamps with tall grass are suitable for *Anopheles hyrcanus* group; sago swamps in Irian Jaya are suitable for *Anopheles koliensis*; and swamps with dense forests are suitable for *Anophelesumbrosus*. Water sources in mountainous and hilly areas are often used as breeding places for *Anopheles* mosquitoes. maculatus as a malaria vector. Clear water, a daily necessity in residential areas, can be used as a breeding place for *Ae. aegypti*, while water waste polluted by household waste is used as a breeding ground for *Culex. quin-quefasiatus* as a filarial vector [5].

Humans in the activity of raising buffalo, cows, chickens and goats attract mosquitoes, however, residents repel mosquitoes with smoke. Even the presence of livestock around settlements can be used as a barrier, so that contact between mosquito bites and humans is reduced. *Zooprophylaxi*s is a biological method that aims to prevent and prevent contact between mosquitoes and humans in an effort to control disease vector mosquitoes. Zooprophylaxis can be combined with insecticides to reduce the incidence of malaria caused by *P. falciparum* by 56% and *P. vivax* by 31%, with costs around 80% lower than the indoor Residual spraying method [13]. Mosquitoes can suck blood from various hosts which can be divided into three. Mosquitoes that prefer to suck human blood are grouped into anthropophilic mosquitoes. Zoophilic mosquitoes are mosquitoes that prefer to suck blood from animals. Indiscriminate mosquitoes are a group of mosquitoes with no particular preferences. However, in general, Anopheles mosquitoes are zoophilic, exophagic and exophilic and actively bite in the middle of the night. In Malaysia, research on anthropophilic Anopheles is still very rare, especially in hilly areas where malaria is endemic. Anopheles mosquitoes in searching for prey are heterogeneous, meaning that there is no host selectivity to obtain prey as a blood source [7]. Mosquitoes are very adaptive and quickly look for substitute prey, if the preferred host is not found in their environment. One of the reasons mosquito preferences for a host is genetic differences, but there is no doubt that in many cases the availability of hosts plays an important role and even determines the anthropophilic and zoophilic characteristics in an area.

Conditions of mosquitoes as malaria vectors

Mosquitoes can act as vectors if they meet the following requirements: (a) Mosquito vectors have quite high contact with humans, in this case expressed in the density of people biting (MBR). (b) Mosquito vectors are a species whose numbers are always dominant when compared to other species. (c) Populations of the species in question generally have a fairly long lifespan, in terms of the percentage of mosquitoes. (d) Elsewhere it turns out that the species has been confirmed as a vector. In measuring the potential of mosquito species to act as vectors of malaria, calculations are made based on vectorial capacity. Vectorial capacity shows the level of receptivity or vulnerability of an area from the aspect of mosquito vectors in maintaining transmission. Quantitative calculations regarding the ability of a mosquito species as a vector are an easier way to express the risk of malaria transmission.

Determining when malaria transmission occurs is calculated as the value of vectorial capacity (VC). In general, a vectorial capacity value above 0.03 is an opportunity for transmission to persist in an area [5]. In measuring the potential and monitoring transmission, a vectorial capacity model is used based on quantitative agent reproduction. This vectorial capacity is determined by four factors, including the anthropophilic index versus the host's blood sucking interval in days, the number of contacts per person per night, the average daily survival probability of the vector and the number of days in the sporogony cycle. Transmission value for *Anopheles Aconitus*, the vectorial capacity value was obtained = 0.21134. Based on the analysis above, *Anopheles aconitus* has the potential to transmit malaria from *P. vivax*. Research in Gujarat, India showed a vectorial capacity value of between 0.0005 up to 0.5649, it turns out that *Anopheles culicifacies* can act as a transmitter of Plasmodium. It seems that *Anopheles culicifacies* is more sensitive compared to *Anopheles aconitus* must be able to maintain malaria transmission at a fairly high vectorial capacity value, meaning with a density of if *culicifacies* are low, transmission can continue. A vectorial capacity value above 0.03 is an opportunity to maintain malaria transmission in an area. According to theory, 0.01 is a critical value of vector capacity for malaria situations. Experience shows that the vector capacity value is at least 0.03 for the ongoing transmission of malaria. The vector's ability to transmit agents is influenced by several factors including (a) host specificity, (b) vector life span, (c) feeding frequency, (d) vector mobility, (e) vector population level and (f) adaptation activities. Thus, vectorial capacity and the ability of vectors to transmit disease are influenced by the level of the vector population [8].

Types and distribution of malaria vectors in Hindupur mandal, Andhra Pradesh, India

In Hindupur mandal, Andhra Pradesh, India, 80 species of Anopheles have been reported, but only 20 of them have been proven to transmit Plasmodium and are spread across various islands. The archipelagic ecosystem has a very strong influence on vectors, causing the vector population to be unstable, adapting to high humidity as a result of limiting flying distance, distribution in the form of clusters, looking for damp perching places (outside the house), many deaths in the dry season.[14]

Various types of mosquitoes are also found in Hindupur mandal, Andhra Pradesh, India and their distribution covers all regions of Hindupur mandal, Andhra Pradesh, India, in Maluguru village there are many types of mosquitoes from from the oriental region. In the remaining provinces only oriental mosquito species are found. The various types of mosquitoes found in each location are determined by environmental factors. So certain types of mosquitoes in Hindupur mandal, Andhra Pradesh, India are different from mosquitoes in Hindupur mandal, Andhra Pradesh, India. Mosquitoes live in nature in almost all places, both in rural areas and in cities, according to epidemiological units, from beaches to mountains and forests. In maintaining the balance of the mosquito ecosystem in nature, the population is regulated by predatory animals so that the larvae population is eaten by fish, young frogs, coleoptera, dytiscidae, while the adult mosquitoes are preyed upon by spiders, mites, lizards, birds, bats and geris.

In Hindupur mandal, Andhra Pradesh, India, the mosquito that has been proven to be a malaria vector is *Anopheles bancrofti, Anopheles koliensis, Anopheles farauti*, *Anopheles subpictus*, *Anopheles barbirostris*, *Anopheles* sundaicus and which has potential as a vector (when dissected, oocytes were found), namely *Anopheles vagus*. In Bevina Halli village, the mosquito that acts as a malaria vector is *Anopheles barbirostris*, *Anopheles sundaicus, Anopheles kochi, Anopheles nigerrimus*, and the potential vector is *Anopheles fla-virostris, Anopheles barbumbrosus, Anopheles minimus* and *Anopheles sinensis.* In Chalivendala village, the mosquito that acts as a malaria vector is *Anopheles balabacensis, Anopheles leucosphyrus and Anopheles sundaicus* while the one that has potential as a vector is *Anopheles letifer* and *Anopheles tessellatus*. In Hindupur, the mosquito that acts as a malaria vector is *Anopheles kochi*, *Anopheles* *sundaicus*, *Anopheles tessellatus* while the potential vector is *Anopheles nigerrimus*, *Anopheles maculatus*, *Anopheles letifer* and *Anopheles umbrosus*. In Manesamudram village, the mosquito that acts as a malaria vector is *Anopheles sundaicus* while the one that has potential as a vector is *Anopheles subpictus*. In Kirikera & Kotipi villages, the mosquito that acts as a malaria vector is *Anopheles Aconitus*, *Anopheles balabacensis*, *Anopheles maculatus* and *Anopheles sundaicus*. Meanwhile in Nakkalapalle village, the mosquito that acts as a vector for mosquitoes is *Anopheles sundaicus, Anopheles Aconitus* and *Anopheles balabacensis*. To become a malaria vector, female Anopheles mosquitoes must live at least 9 to 16 days to support sporozoite development. This is related to the sporozoite cycle in the mosquito's body lasting 8 to 16 days. These infective sporozoites enter the mosquito's salivary glands to be transmitted into the human body [15].

Negative Impact on Socio-Economy

The main cause of death in developing countries (75% in Africa and 25% in Southeast Asia). 100 million Indinan live in malaria endemic areas. Currently, it is estimated that there are 10 million clinical cases, with 3 million positive cases [16]. The situation is made worse by the high prevalence of resistance to anti-malarial drugs. Economic losses due to loss of individual income. Weather factors play a role in the spread of malaria both directly or indirectly [17]. India, which is located in the tropics, is rich in types of insects, both useful for human life and harmful. One of the groups of insects that harm humans is mosquitoes. Anopheles mosquitoes can transmit malaria to both humans and animals. Mosquitoes through their bites can transfer disease agents (Plasmodium and worms) from sick people to healthy people. Based on this, insects, especially mosquitoes, have an important meaning in human life. Therefore, humans try to understand all aspects of mosquito life by observing, researching and trying to control so that mosquitoes do not cause problems.

Conclusion

1. Mosquitoes are living organisms that are abundant in nature almost everywhere.
2. The presence of *Anopheles* spp mosquitoes can have a negative impact, causing disturbances and playing a role in spreading several diseases which are influenced by several factors including host specificity, vector life span, feeding frequency, vector mobility, vector population level and adaptation activity. self.
3. In general, malaria vectors in Hindupur mandal, Andhra Pradesh, India have zoophilic and slightly anthropophilic behavioural characteristics which are different in each endemic area, and are exophagic and exophilic as well as different entomological health parameters. But in several areas of NTT, the mosquito *Anopheles barbirostris* and *Anopheles sundaicus*, which is the main vector of malaria, is generally anthropophilic.
4. The dynamics of transmission caused by mosquitoes has different vectorial capacity values at each location. In general, vectorial capacity values above 0.03 have the opportunity to transmit disease.
5. Transmission dynamics are closely related to several environmental factors, including vector population dynamics, malaria prevalence, rainfall, local socio-culture so that the problem is very complex.

Conflict of Interest

The authors declare that they have no conflicts of interest.

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