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ON TAXONOMY OF MALARIA VECTORS OF INDIA

By

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INTRODUCTION

'Taxonomy' is the foundation of all sciences. It is the key to the most complex questions. Insect taxonomy has a direct bearing on studies relating to tropical medicine and hence indirectly on national economy. Resurgence of malaria in our country has become a serious problem. All malarial countries are seriously handicapped and their natural development towards the highest economic and industrial efficiency is materially retarded.

Female *Anopheline* mosquitoes act as vectors of human malaria. Taxonomy of vector *Anopheline* mosquitoes has been done by various workers, resulting in the correct elucidation of malaria vectors of different regions of our country. Certain anomalies, however, exist. In this communication an attempt has been made to clarify the anomalies and throw light on the exact position of those Anophelines responsible for transmission of malaria.

TAXONOMY

'*Anopheles*' literally means in Greek *an* (privative) and *ophelos* ("advantage" or "use"). The term was introduced by Meigen in 1818 (Terminology of malaria, WHO, 1963).

The genus includes over 400 species and subspecies (Foote and Cook, 1959). Uptil year 1900, it was only known that transmission of human malaria was carried out by *Anopheline* mosquitoes. Stephens and Christophers (1902), however, point out that only certain species of *Anophelines* carry malaria in nature, while others do not.

Only 91 species are reported to be vectors of malaria in the whole world, 33 species in the Oriental region and 13 species and subspecies in India.

The basic taxonomic unit in animal kingdom is the species. A number of species consist of subspecies. The latter become geographically isolated from the parent species. Taxonomically significant genetic divergence is observed in them.

Ten *Anopheline* species labelled as vectors of malaria in India are as follows :

1. *A. sundaicus*, 2. *A. varuna*, 3. *A. philippinensis*, 4. *A. stephensi*, 5. *A. culicifacies*, 6. *A. fluviatilis*, 7. *A. minimus*, 8. *A. annularis*, 9. *A. jeyporiensis*, 10. *A. leucosphyrus*

A. sundaicus (*A. ludlowii*) was previously known as *A. ludlowi* and was described as *A. vagus* by Schuffner *et al* (1917). Roy and Brown (1970) state that considerable difference exists between *A. ludlowi* of Philippines and *A. sundaicus* found in India.

Adults of *A. varuna* were first discovered by Iyengar (1924) from specimens collected in Bengal. It was treated as a variety of *A. minimus* and was mistaken with *A. fluviatilis* due to morphological similarities (Edwards, 1922). Some references to *A. listonii* especially in respect to breeding in wells, probably relate to *A. varuna*.

A. philippinensis was referred to as *A. fuliginosus* (Station, 1915). It was commonly known in India and Malaya as *A. nivipes* or *A. fuliginosus* var. *nivipes*. *A. philippinensis* was at one time confused with *A. annularis* (Christophers, 1924), but later on the confusion was cleared.

A. stephensi, which is the most efficient vector of malaria in urban areas, has been synonymised as *A. metaboles* (James and Liston, 1911), *Neocellia intermedia* (James and Liston, 1911) and *A. folquei* (Christophers, 1924). It has been separated into two races on the evidence of the size of the eggs and wing length (Sweet and Rao, 1937).

A. culicifacies previously referred to as *Myzomyia culicifacies* was collected by Fry in Bengal as early as 1912 (Fry, 1912). Other synonyms are *A. listonii* (Giles, 1901), *A. indica* (Theobald, 1901) and *A. punjabensis* (James and Liston, 1911). *A. culictifacies* var. *punjabensis* has been recorded from Punjab. Another variety, *A. culicifacies* var. *adensis* has not been recorded from Indian area.

A. fluviatilis was synonymised as *A. listonii* (Edwards, 1932) and *Myzomyia leptomeres* by Christophers (1924). It was regarded together with *A. minimus* because of similar habits.

There has been a great deal of confusion regarding the nomenclature of *A. minimus*, until Edwards (1915) established the synonymy of *A. christophersi* Theo. as *A. minimus*, following his previous distinction of this form from *A. listonii*. Even upto quite recently the identification of these related forms has been very uncertain, (Christophers and Puri, 1931).

A. annularis has many synonyms. It was known as *A. fuliginosus* by earlier writers ; Christophers (1924) states that it comprises of two species, *A. annularis* and *A. philippinensis*.

A. jeyporiensis has been reported to consist of two varieties—(1) *A. jeyporiensis* (type form) and (2) *A. jeyporiensis candidiensis*. Both are found in India and have been included in the list of malaria vectors.

A. leucosphyrus is a jungle species. This group contains about 13 forms, all forest forms.

It consists of two important sub-species, *leucosphprus* and *balabacensis*. *Balabacensis* is elevated to specific status by Colless (1957). The behaviour of the two is identical (Colless, 1950).

A. leucosphyrus has recently been shown to be a composite species (Roy and Brown, 1970), and includes 7 different forms or sub-species.

A. l. balabacensis is the commonest member and shows marked preference for human blood. According to Reid (1949), *A. leucosphyrus* includes the following forms—(1) *leucosphyrus lypicus*, (2) *l. balabacensis*. (3) *l. clegans*, (4) *l. hackeri*, (5) *l. punjabensis*, (6) *l. riparis* and (7) *l. christatus*. According to Kalra and Wattal (1962) three members of the *A. leucosphyrus* group (i. e., *A. balabacensis* (type), *A. leucosphyrus* (type) and *A. leucosphyrus* celebes form) are incriminated as vector of malaria. The differentiating features of *A. clegans*, *A. balabacensis* and *A. leucosphyrus leucosphyrus* are given by them.

DISCUSSION

Identification of the exact vector species, geographical distribution and knowledge about their bionomics are essential to formulate a strategy against malaria. Destruction of all *Anopheline* adult and larvae is not possible and control is not feasible till the species actually taking part in the transmission of the disease is known.

Ten *Anopheline* species and their varieties (one each of *stephensi*, *A. jeyporiensis* and *A. leucosphyrus*) are at present known to transmit malaria in India. The number may further increase with further research.

Differentiation of species into sub-species has been done on the basis of differences in egg length, egg width, length of the float, number of ridges of egg float, the length of wings, and in the habits of the adults. (*A. stephensi* or *A. mysorensis*).

Taxonomically, a species such as *A. stephensi* should exhibit similar habits and habitats in all area, but at times this varies. Exophilic and endophilic habits of *A. stephensi* are exhibited in different geographical

region. This peculiar phenomenon may occur due to resistance to insecticide, which is termed as 'behaviouristic resistance'

A. stephensi of Calcutta which is resistant to DDT, dieldria and Abate is endophagus but exophilic (Mukhopadhyay, Tandon and Hati, 1977, and Hati, Tandon and Mukhopadhyay, 1978).

In some areas, principal vectors are known to have disappeared, their place is being taken by secondary vectors. *A. minimus* is reported to have disappeared from Assam. (Report of the Evaluation in Depth of NMEP, 1970), and *A. philippinensis* and *A. varuna* could not be recorded from West Bengal and Calcutta city respectively. (Ghosh *et al*, 1966 ; Das *et al*, 1971). However, in recent catches in the suburbs of Calcutta, *A. varuna* has been identified (unpublished data, 1977). *A. fluviatilis* which was once the only vector of malaria in the foot hills of Nilgiris (Russel and Jacob, 1942) had been reported to be on the verge of disappearance (Rahman, 1973). Recent reports, however, claim their reappearance. (Tour report, Regional Director, NMEP, Bangalore, 1976).

Regarding transmission of malaria by the *Anopheline* species recorded above, it has been stated that the vectorial capacity of a particular *Anopheles* species may vary fron place to place. Roy and Brown (1970) state that the vectorial potential of *A. philippinensis* and *A. varuna* is not constant everywhere. Although *A. philippinensis* has been reported from Bengal, Assam, India, Burma and Indo China, infection has been recorded only in Bengal, Assam and Burma.

Similarly *A. varuna* is reported to be an important carrier in the Singhbhum hills and in the Eastern Satpura Range (Senior White, 1937) but it is quite harmless in Vizagapatnam and Orissa coastal belt.

It is, however, a proved vector in Travancore and near Calcutta.

One variety, each of *A. culicifacies* and *A. minimus* (the one found in India), along with *A. fluviatilis* are very important malaria carrying species in the country.

Both the varieties of *A. stephensi*, *A. jeyporiensis* and *A. leucosphyrus* are equally efficient as vector of malaria.

There is considerable difference between *A. ludlowi* of the Philippines and the from *A. sundaicus* present in India, Java and Thailand. Malaria that occurs in coastal regions of India is due to *A. sundaicus*. In the Philippine Islands, *A. ludlowi* breeds in fresh water, whereas the other variety *littoralis* in brackish water (Roy and Brown, 1970).

In certain parts of South East Asia, *A. balabacensis* is a more efficient carrier of resistant *falciparum* malaria in comparison to

A. minimus (Wilkinson *et al*, 1976). The reason is, however, not so clear.

CONCLUSION

Inspite of the present knowledge, a careful assessment of appearance and disappearance of important primary and secondary vector species, change in their vector potential and change in their susceptibility status to the commonly used insecticides (DDT, dieldrin and organophosphorus compounds) should be done at regular intervals in malarious areas to combat the disease in a successful manner.

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SUMMARY

There are 13 species and subspecies of *Anopheles* mosquitoes in India, the females of which act as vectors of human malaria. Taxonomic identification of *Anopheles* spp., geographical distribution and exact knowledge of its biology are essential to formulate a strategy against malaria. An attempt has been made in this paper to determine the taxonomy of the *Anopheles* spp. found in India.

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