

with compliments

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**Some new records of Anopheline Mosquitoes
from the Malay Peninsula with remarks on
Geographical Distribution**

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Some new records of Anopheline Mosquitoes from the Malay Peninsula with remarks on Geographical Distribution

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Anopheles minimus Theobald, 1901.

Both Christophers (1933) and Gater (1934) treat this species as occurring in the Malay Peninsula, but in recent years there do not appear to have been any records or specimens of it at this Institute. Covell (1944) does not record it from this country, but Sandosham (1944) states that it has been recorded on a few occasions from the north of Kedah. It seems possible that the record of *minimus* as a Malayan species may be due in part to Theobald (1903, p. 27) who under the name *listoni* (with which he synonymises *christophersi*) records it from Perak collected by Wright. It is now accepted that *christophersi* is a synonym of *minimus* and *listoni* of *fluviatilis*. It seems possible that Wright's specimen might have been the common Malayan species *aconitus*, and that Theobald misidentified it as his *listoni*. Only an examination of the specimen, if still extant, could settle this point.

In April last year Dr. T. Wilson sent a few specimens of *minimus*, collected at Kaki Bukit, Perlis, near the Siam border, by Mr. Jones, Anti-Malaria Inspector of the Perlis Medical Department. As *Anopheles minimus* is one of the most potent vectors of malaria in the Oriental region, further investigation was necessary, and in February this year the writer visited Kaki Bukit in company with Dr. Wilson and Mr. Jones. It appears that the larvae of this species were first discovered in a stream just inside the anti-malarial oiling area of Kaki Bukit village, and it is probable that they had been washed through the natural tunnel cut by the stream in the limestone hill, from Wang Tangga beyond. On making our way through this tunnel, which is the normal route into the enclosed valley of Wang Tangga, we were able to find larvae at suitable points along the banks of the stream, especially above the point where effluent from a tin mine discharged into it. The banks were steep and descended more or less vertically into the water, which was at a low level at the time. By wading up the stream and dipping along the edges at points where grass or other vegetation grew in the water and gave shelter from the sun, and the force of the current, considerable numbers of larvae were obtained.

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This type of breeding place appears to be very characteristic of *minimus* (vide Christophers, 1933 and Thomson, 1941).

Relation to malaria.—It is not known whether *A. minimus* transmits malaria at Wang Tangga, but it seems probable, since there is stated to be a considerable amount of malaria in the place, and *minimus* has the reputation of being a vector wherever it occurs. A search in similar areas along the Malayan side of the border, at least on the west side of the main range, would probably disclose other places where *minimus* occurs.

Identification.—*Anopheles minimus* closely resembles *A. aconitus* which is common in this country, but is distinguished from it as an adult by lacking the pale fringe spot at the termination of vein 6, and by having the terminal half of the proboscis largely dark, instead of all pale golden as in *aconitus*. The larvae have simple anterior clypeal hairs; those of *aconitus* are strongly frayed. For a detailed description of this species and the others dealt with in this articles, see Christophers (1933) and Gater (1934 and 1935).

Specimens.—Perlis: Kaki Bukit, 2.iv.48, 1 ♂ (T. Wilson); Wang Tangga, 7.ii.49, 17 ♀, 11 ♂.

Anopheles ramsayi Covell, 1927.

This species is not recorded as occurring in the Malay Peninsula by either Christophers, Gater or Covell, though it is mentioned by Sandosham (1945) in a corrigendum. It has however been known for some years that it occurs occasionally in the neighbourhood of Alor Star, Kedah, and there is a single specimen in the collection of this Institute obtained at Alor Star in 1938. During 1938 and 1939, Mr. K. N. G. Pillai, Chief Health Inspector of the Kedah Medical Department, who first noticed this species at Alor Star in 1937, discovered that it bred in considerable numbers towards the end of the year, at certain places on the coastal plain. In February this year in company with Dr. Wilson and Mr. Pillai, the writer visited one of these places, Kg. Ayer Hitam, which lies about 12 miles north-west of Alor Star. Breeding was considerably diminished, and one pond in which larvae of *ramsayi* had been found a few weeks before, yielded none; but diligent search in a second pond produced a few larvae which were brought back safely to Kuala Lumpur and reared to adults. So far *A. ramsayi* has not been reported from anywhere south of Alor Star, and where it occurs the larvae are found only in ponds with a dense cover of the water lettuce, *Pistia stratiotes* (Kiambang). Sen (1941) notes that in Bengal it is almost exclusively associated with this plant. These ponds, or tanks, serve as a permanent water supply for the people, and at the time of our visit they were almost the only places holding water. The *Pistia* is said to

retard evaporation and to keep the water cool; it certainly does the latter. The larvae are small and entirely black except for a trace of a white band behind the head; they cling closely to the *Pistia* plants and if dislodged, rapidly hide again amongst them. They were found in company with the larvae of *Anopheles hyrcanus*.

Relation to malaria.—*Anopheles ramsayi* has been found infected with malaria parasites in Assam, but there have also been many negative dissections, and it is not regarded as of any importance as a vector in the Indian area (Covell, 1944). Over most of the Kedah coastal plain the general incidence of malaria is low, but there are reports of more cases occurring in the Ayer Hitam area about December–January when *A. ramsayi* is most abundant; such increase might perhaps be due to other factors, such as persons coming from malarious areas to help with the rice harvest. Mr. Pillai, however, cites two localised outbreaks of malaria in the neighbourhood of Alor Star in 1937 and 1939 which ceased when a few nearby breeding places of *ramsayi* were destroyed, although breeding places of *A. barbirostris* remained numerous. It was the 1937 outbreak which led to the discovery of *ramsayi*.

Identification.—*A. ramsayi* is a very small species; like *philippinensis* and *annularis*, it has the last three tarsal segments of the hind legs entirely white, but it differs from these two Malayan species by having the femora and tibiae speckled with white. The larvae have only a few short side branches on the outer clypeal hairs; those of *philippinensis* and *annularis* have numerous long branches giving the hairs a brush-like appearance.

Specimens.—Kedah: Alor Star, 4.viii.38, 1 ♂ (E. P. Hodgkin); Ayer Hitam, 8.ii.49, 8 ♀, 5 ♂.

***Anopheles aurirostris* Watson, 1910.**

This rare species is not known from anywhere but the Malay Peninsula, so that the present record is not new in the sense of recording a species hitherto unknown from this country; but as *aurirostris* does not seem to have been collected since 1921, its rediscovery seems worth a mention. A few immature larvae from which adults were reared, were collected by the writer in May, 1948, very close to the type locality, Merton Estate, Klang. The following is a summary of the previous records of this species so far as they are known.

1. Watson (1910). "Bred from two larvae, taken from a hole in the ground 1½ feet wide and 2 feet deep in the jungle next to Merton Estate, Klang, December, 1909". Adult female described; type ♀ in Liverpool School of Tropical Medicine.

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2. Hacker (1920). Mouth of the Perak river, January, 1918, 8 collections, 13 larvae. Brackish pools at the roots of mangrove and Nipah palms. Larva described.
3. Gater and Rajamoney (1929). They summarise the Malaria Bureau records of 18 collections comprising 44 larvae, and conclude that *aurirostris* is "a rare species, only recorded from one locality. It is found near the sea, possibly in brackish water, but no analysis is on record". There are three old specimens in the collection of this Institute, one of which is labelled, W. A. Lamborn, 27.xi.1921. It is probable that the records analysed by Gater and Rajamoney refer to the collections made by Hacker (No. 2 above), and by Lamborn who presumably revisited the locality.

The impression gained from these records is that the species should be looked for in mangrove near the sea, but a map shows that the type locality, Merton Estate, is some 12 miles up the Klang river. The larvae found by the writer were in shallow pools in short dense jungle bordering the banks of the Klang river which are quite high at this point. The river is tidal here, though possibly not brackish, with characteristic plants and trees such as *Acanthus ebracteatus* (Daun Jeruju) and *Sonneratia acida* (Berembang) growing on the slope of the bank in the tidal zone. But the jungle on top of the bank is mainly composed of ordinary dry land or freshwater swamp species so far as one can see, with the addition of some, such as *Flagellaria indica* (Rotan dini) and *Fagraea crenulata* (Birah), which are rather characteristic of the back of the tidal zone. Behind the narrow strip of jungle is rubber and lalang. However in this jungle, which is on a heavy gray clay soil, may be seen small mudskipper fish (*Periophthalmus*) and fiddler crabs which evidently come up from the river. A search of similar zones up other rivers would be worth while, for it seems just possible that such places are the real station of this species rather than more truly coastal areas. It is perhaps significant that prolonged and careful investigations of the Selangor coast between Klang and Jeram, from 1935 to 1940 (Hodgkin 1936-41) did not reveal any *A. aurirostris*, although all the other coastal species were frequently collected. Analysis of water from the breeding place showed that it was fresh, containing only 0.46 parts of chlorides per 100,000, with a pH of 7.0.

Specimens.—Selangor: banks of the Klang river, near Merton Estate, Damansara, 2.v.48, 2 ♀, 2 ♂; 25.v.49, 18 ♀, 7 ♂.

GEOGRAPHICAL DISTRIBUTION

The discovery of *Anopheles minimus* and *ramsayi* in the north of the Peninsula, focusses attention on an interesting problem of zoogeography. There are several species of *Anopheles*, including *minimus* and *ramsayi*, which have a markedly discontinuous distribution; they are found freely in the monsoon countries to the north of the Peninsula, but are more or less absent from the Peninsula, yet present in the Archipelago, particularly Java and Sumatra. Species with this type of distribution are tabulated below.

TABLE I
Distribution of certain species of *Anopheles*.

Species	DISTRIBUTION (FROM COVELL, 1944 AND GATER, 1935)		
	Indian area	Malay Peninsula	N.E.I.
√ 1. <i>annularis</i> ..	Ind., Cey., Burm., Siam, Indo-China.	Not further south than about Batu Gajah.	Sum., J., Born., Lesser Sunda Is.
√ 2. <i>minimus</i> ..	Ind., Cey., Burm., Siam, Indo-China.	Perak North Perlis ..	Sum., J*, Born*, Bali*, Celeb., Moluccas.
√ 3. <i>pallidus</i> ..	Ind., Cey., Burm., Siam	Perak, † one specimen ..	Sumatra
√ 4. <i>ramsayi</i> ..	Ind., Cey., Burm., Siam	North Kedah ..	Sumatra, Java
√ 5. <i>varuna</i> ..	Ind., Cey., Burma. ..	Absent ..	Sumatra

Malcolm Smith (1930) records a similar anomalous distribution for some fifteen or more species of reptiles and amphibians. He says "an interesting problem in geographical distribution is connected with a number of species which are to be found in the northern part of the Peninsula and in the Malay Archipelago, but not in the southern part of the Peninsula. The reason for this discontinuous distribution has not been explained". More recently Corbet (1941) has drawn attention to a similar distribution in certain species of butterflies, and Zeuner (1941) has put forward a partial explanation based on climate. Corbet says "of the 924 species of butterflies recorded from the Malay Peninsula, 35 are known only from a small area in the north-west corner of British Malaya which comprises the small northern state of Perlis, that part of Kedah north of the Kedah river, and the Langkawi islands". For brevity Corbet refers to this area as "Kedawi". He shows that 18 out of the 35 Kedawi species occur also in Sumatra, Borneo or Java, and says "it is a curious fact that several species which are more or less restricted to Kedawi as far as British Malaya is concerned, occur also in Sumatra and/or Borneo". Corbet points out that Ridley (1911) found the flora of the Siamese Malay states to be quite distinct from that of Malaya proper,

**minimus* var *flavirostris*.

†Gater, 1935, Sandosham, 1944.

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many characteristic Malayan genera being absent, and he placed the boundary line near Alor Star on the Kedah river.

There are then at least four groups of animals; reptiles, amphibia, butterflies and mosquitoes; which show this discontinuous distribution, being found in the north of the Peninsula but not in the south, and occurring again in the Archipelago. Zeuner, in considering Corbet's data, analyses the figures of rainfall in Malaya tabulated by Stewart (1930). He calculates a "seasonal index" for each recording station, by expressing the rainfall of the driest month as a percentage of that of the wettest month, and plotting the resulting percentages against total rainfall. His valuable diagram, slightly modified, is reproduced below.

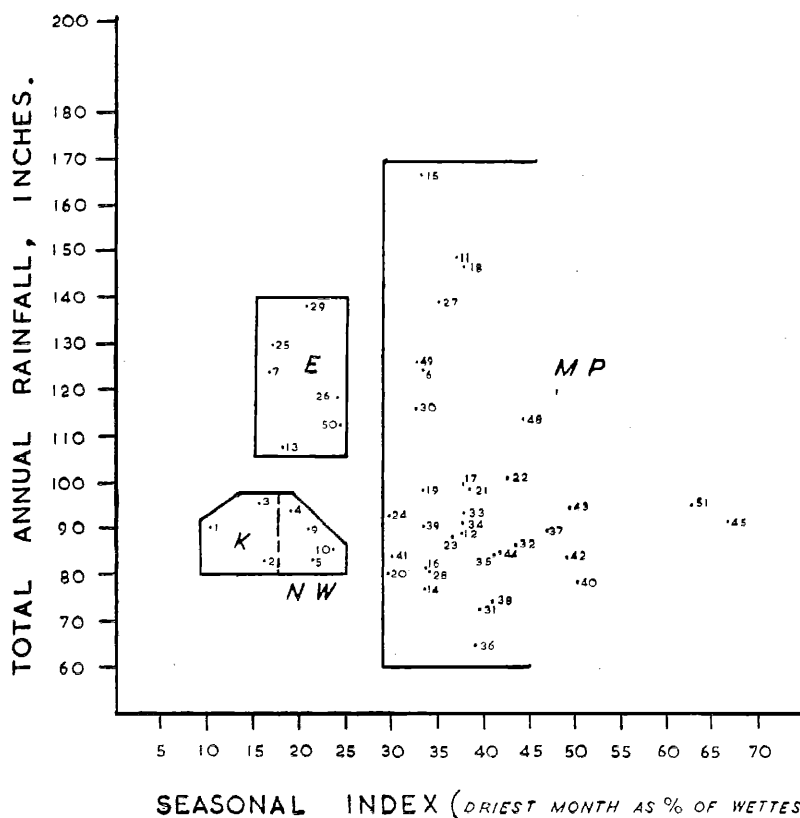


Fig. 1. (After Zeuner, 1941). The seasonal variation of rainfall in British Malaya, based on Stewart (1930). Only stations with 10 or more years records are shown; numbering of stations as in Stewart. Areas defined by boundary lines in the diagram:—*M.P.*, Malaya proper; *E.*, East Coast; *N.W.*, North-West; *K.*, 'Kedawi' (1. Langkawi, 2. Perlis, 3. Alor Star).

Zeuner states "the result is most illuminating. Whilst 'Malaya proper' constitutes a comparatively uniform region with the rainfall of the driest month being one-third to two-thirds of the wettest, two areas with pronounced dry seasons are revealed. One is the east coast; it is not of interest in this context. The other is the north-west corner of British Malaya, including Dr. Corbet's 'Kedawi'. This north-west area is not the driest part of British Malaya, since the annual total is, in the average, much the same as in Malaya proper, but it has the greatest seasonal extremes. The driest month receives from one-tenth to less than one-quarter of the rainfall of the wettest month. Within the north-west area, the three stations belonging to Kedawi (1. Langkawi, 2. Perlis, 3. Alor Star) are, in turn the most extreme, and the absolute extreme is represented by Langkawi island".

Zeuner goes on to point out that these conditions represent an approach to the climate of the monsoon countries lying to the north, such as Siam and Burma, and that the prevalence of limestone in this Kedawi region probably accentuates dryness. He concludes that the southern limit of the Kedawi fauna is probably at present a climatic one, and further suggests that the limits of the Malaysian sub-region as a whole are probably determined by climatic as well as by geographical boundaries, "thus, it appears that the Malaysian sub-region with its rain forest climate is at the present day bordered in the north and in the south-east by areas with a climate with pronounced dry seasons. The transition from one type of climate to another coincides in both cases with geographical obstacles to migration: in the north, the bottleneck of the northern part of the Peninsula, in the south-east, the sea channel between Bali and Lombok. The present day conditions thus explain very well why the uniform character of the Malaysian fauna is being maintained". For a full discussion of the biogeography of this region see Scrivenor, Burkill *et al* (1943).

Zeuner's suggestion that the southern limit of the Kedawi fauna in the Peninsula is a climatic limit, appears probable. It is difficult to see what barrier there can be, other than a climatic one, to prevent the southward spread into the rest of the Peninsula, of a vigorous and widespread species of mosquito such as *Anopheles minimus*; especially when one recalls the rate of spread (roughly 12 to 75 miles per annum) of *Anopheles gambiae* in Brazil when introduced there accidentally from Africa (Soper and Wilson, 1943). In what way the climatic barrier acts upon the various members of the Kedawi fauna, especially the mosquitoes, to restrain their southward spread, is a separate problem, but granted that it is the absence of a pronounced dry season in the Peninsula proper which is the

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restraining influence, this still leaves half the puzzle unexplained. Why should many of these Kedawi species, including all the mosquitoes, occur again in Sumatra which has a climate very similar to that of the Peninsula proper? Scrivenor (1943) classes Sumatra, Borneo, Celebes, and the Peninsula minus Kedah, as a region where seasonal variations are slight. Examination of rainfall maps of Sumatra (Boerema, 1931), kindly loaned by the Director, Malayan Meteorological Service, shows that for eight stations,* which are also localities from which the mosquitoes have been recorded (Swellengrebel and Rodenwaldt, 1932), the seasonal index in seven appears to be between 30 and 40 per cent, with a total annual rainfall varying from about 60 to 170 inches, i.e., very similar to the bulk of stations in the Peninsula. There seems to be no explanation of this anomaly at present.

There is another point about the geographical distribution of *Anopheles* in the Malaysian sub-region that is worth noting here, as it is probably also connected with climate. It is that, broadly speaking, the sub-genus *Anopheles* (especially the series *Myzorhynchus*), is best developed in this part of the Oriental region with its rain forest climate, while the sub-genus *Myzomyia* is dominant in the monsoon countries to the north.

Table II, based on the distribution of species as recorded by Christophers (1933) and Gater (1935), sets out the figures.

TABLE II

Distribution of mosquitoes of the sub-genera *Anopheles* and *Myzomyia* in parts of the Oriental region.

Number of species	Assam, Burma, Siam, Indo-China, (Christophers, 1933)		Malaya, Sumatra, Java, Borneo. (Gater, 1935)	
	<i>Anopheles</i>	<i>Myzomyia</i>	<i>Anopheles</i>	<i>Myzomyia</i>
Total ..	7	22	18	21
Number not shared with the other region ..	0	7	12	5

It is thought that the two regions chosen can fairly be compared. India has been omitted from the first region, because there are a number of species, at least in north-west India, which properly belong to the Mediterranean fauna. Similarly

* These stations are Mera Tebo, Kota Rajah, Batang Toru, Lubok Sikaping, Fort de Kock, Padang Panjang and Solok. Padang Sidempuan appeared to have a seasonal index of about 12 per cent.

the eastern parts of the Malay Archipelago have been omitted as they contain some elements of the Australasian fauna. The table shows that the sub-genus *Anopheles* contains about half (46 per cent) of the anopheline fauna in the Malaysian region, but only about a quarter (24 per cent) in the Burmo-Chinese region. Furthermore two-thirds (12/18) of the sub-genus *Anopheles* in the Malaysian region do not occur in the other region, which in contrast has no species of this sub-genus which it does not share with the Malaysian region. Among the twelve species of the sub-genus *Anopheles* peculiar to the Malaysian region, eight belong to the series *Myzorhynchus*. Finally it may be noted that the five species of mosquitoes with the discontinuous distribution (Table I) all belong to the sub-genus *Myzomyia*.

SUMMARY

1. *Anopheles minimus*, a very important vector of malaria, has been found at Kaki Bukit, Perlis, near the Siam border. *Anopheles ramsayi* is recorded from the coastal plain of Kedah, north-west of Alor Star.

2. *Anopheles aurirostris* has recently been collected in the type locality, near Damansara, Selangor. The last record of this species was in 1921 from near the mouth of the Perak river.

3. *A. minimus* and *ramsayi* have a peculiar discontinuous distribution. Though restricted in the Malay Peninsula, so far as is known, to the north-west corner, they occur in Sumatra and Java as well as in the Monsoon countries north of Malaya. Two or three other species of *Anopheles*, some fifteen species of reptiles and amphibia, and eighteen species of butterflies have a similar distribution.

4. The limitation of these species, so far as the Malay Peninsula is concerned, to the north-west corner, appears to be due to a climatic barrier. Zeuner shows that this area has a pronounced dry season not found in the rest of the Peninsula, except on the east coast where the total rainfall is higher.

5. The occurrence of a number of these species in Sumatra which, like the greater part of the Peninsula, has no pronounced dry season, remains unexplained.

6. Among anopheline mosquitoes it appears that the sub-genus *Anopheles*, and particularly the series *Myzorhynchus*, is rather characteristic of the Malaysian rain forest region, whilst the sub-genus *Myzomyia* predominates in the monsoon countries to the north.

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