

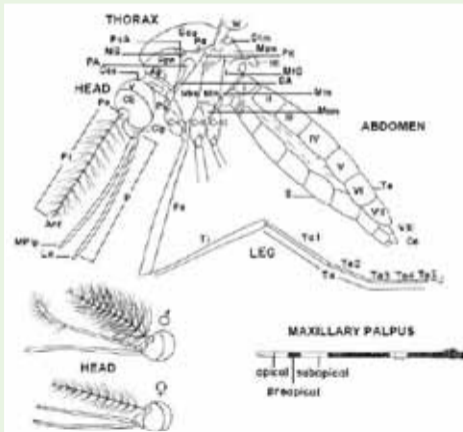
MALARIA VECTORS IN ASIA-PACIFIC COUNTRIES



ANOPHELES DIRUS

APMEN
asia pacific malaria elimination network

ADULT MORPHOLOGY



2

HEAD

Ant	=	antenna
CE	=	compound eye
Clp	=	clypeus
Fl	=	flagellum
La	=	labellum
MPlp	=	maxillary palpus
Occ	=	occiput
Pe	=	pedicel
P	=	proboscis
V	=	vertex

ABDOMEN

Ce	=	cercus
Te	=	tergum
S	=	sternum
I-VIII	=	abdominal segments

ADULT MORPHOLOGY

THORAX

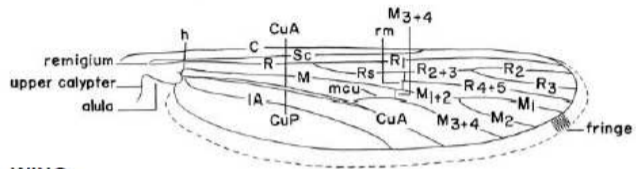
Ap	=	antepronotum	PA	=	postspiracular area
Hl	=	halter	PK	=	prealar knob
Mks	=	mesokatepisternum	Ppn	=	postpronotum
Mm	=	mesepimeron	Ps	=	propisternum
Mpn	=	mesopostnotum	PsA	=	prespiracular area
MS	=	mesothoracic spiracle	SA	=	subspiracular area
Msm	=	mesomeron	Scu	=	scutum
MtS	=	metathoracic spiracle	Stm	=	scutellum
Mts	=	metepisternum	W	=	wing
Pa	=	paratergite			

LEG

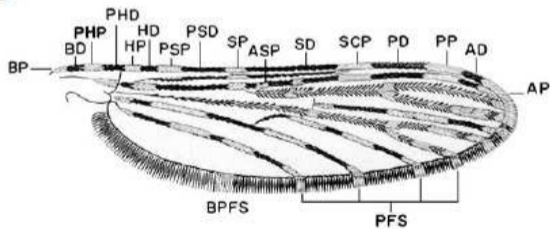
C-I	=	forecoxa	Ta 1-Ta 5	=	tarsomeres 1-5
C-II	=	midcoxa	Ti	=	tibia
C-III	=	hindcoxa	U	=	unguis
Fe	=	femur			

3

ADULT MORPHOLOGY



WING



ADULT MORPHOLOGY

WING VEINS

C	=	costa
CuA	=	cubitus anterior
CuP	=	cubitus posterior
h	=	humeral crossvein
M	=	media
M1, M2, M1+2, M3+4	=	branches of media
mcu	=	mediocubital crossvein
R	=	radius
R1, R2, R3, R2+3, R4+5	=	branches of radius
rm	=	radiomedial crossvein
Rs	=	radial sector
Sc	=	subcosta
1A	=	anal vein

WING SPOTS

AD	=	apical dark
AP	=	apical pale
ASP	=	accessory sector pale
BD	=	basal dark
BP	=	basal pale
BPFS	=	basal pale fringe spot
HD	=	humeral dark
HP	=	humeral pale
PD	=	preapical dark
PFS	=	pale fringe spot
PHD	=	prehumeral dark
PHP	=	prehumeral pale
PP	=	preapical pale
PSD	=	presector dark
PSP	=	presector pale
SCP	=	subcostal pale
SD	=	sector dark
SP	=	sector pale

Anopheles aconitus



DISTRIBUTION

Bangladesh, Cambodia, China, India, Indonesia, Malaysia, Myanmar, Sri Lanka, Thailand, Vietnam

BIONOMICS

Larvae found primarily in flooded rice fields, grassy ponds and stream margins. Also found in Nippa palm swamps, stream pools, fresh water swamps, rock pools, seepage pools, and ditches. In Thailand found at elevations of 1 - 700m. In Indonesia, Java found up to 853m.

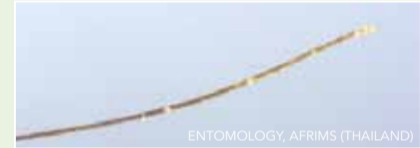
MEDICAL IMPORTANCE

Primary malaria vector.

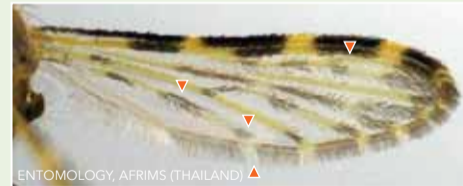
Anopheles aconitus



Proboscis half pale



Leg entirely dark or with narrow apical pale bands or dorsal patches on some tarsomeres



VeinR₂ with median pale spot, vein 1A with pale fringe, veinR₁ with 2 dark spots on distal half

Anopheles annularis



DISTRIBUTION

Cambodia, China, India, Indonesia, Malaysia, Myanmar, Philippines, Taiwan, Thailand, Vietnam

BIONOMICS

Larvae found in clear, still water with abundant vegetation. Habitats include ponds, swamps, rice fields. Adults zoophilic.

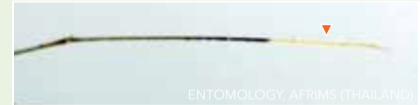
MEDICAL IMPORTANCE

Secondary vector of malaria.

Anopheles annularis



Maxillary palpus with 3 pale bands



Hindfemur, tibia, and tarsomere 1 dark, not speckled with pale scales, hindtarsomeres 3, 4 and 5 entirely white



Vein CuA mostly dark-scaled, with dark spot at fork with vein mcu

Anopheles balabacensis



DISTRIBUTION

Indonesia, Malaysia, Philippines

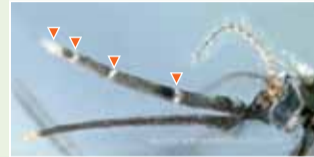
BIONOMICS

Immatures found in heavy shade along edges of swamps, rock pools, stream margins and in temporary roadside ground pools.

MEDICAL IMPORTANCE

Primary malaria vector.

Anopheles balabacensis



Maxillary palpus with 4 or more pale bands



Tibio-tarsal joint of hindleg with large white band, hindtarsomere 4,5 without basal pale band



Dark mark on presector of vein R1 the same length as the corresponding mark on costa, presector dark mark of vein R with at least one pale interruption

Anopheles barbirostris



DISTRIBUTION

Bangladesh, Cambodia, China, India, Indonesia, Laos, Malaysia, Myanmar, Pakistan, Sri Lanka, Thailand, Vietnam

BIONOMICS

Larvae found in open sunny to light shade habitats with all types of vegetation. Habitats include stream and river margins and pools, flowing and stagnant ditches, lakes, rice fields, temporary and permanent ground pools, seepage springs, animal footprints, canals, marshes, fish and rock pools. Adults zoophilic.

MEDICAL IMPORTANCE

Not a vector of human disease except perhaps in the Celebes.

Anopheles barbirostris



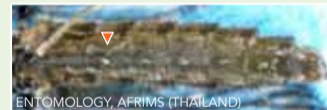
Clypeus without patch of dark scales



Wing apex with only 2 narrow pale fringe spots



Midtarsomeres unbanded



Abdominal sternum with few scattered white scales between median patch and lateral rows

Anopheles culicifacies s.l.



DISTRIBUTION

Afghanistan, Bahrain, Cambodia, China, Eritrea, Ethiopia, India, Iran, Iraq, Laos, Myanmar, Nepal, Oman, Pakistan, Sri Lanka, Thailand, Vietnam, Yemen

BIONOMICS

Larvae are found in fresh water irrigation ditches, rain pools, pools in riverbeds, freshly dug pits or holes and wells. Females avoid oviposition site with emergent vegetation. Larvae found between 35 and 960m. in Thailand; in Vietnam only over 914m. and in Pakistan usually between 1524 - 1829m. but also up to 2286m.

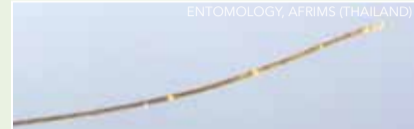
MEDICAL IMPORTANCE

Primary malaria vector.

Anopheles culicifacies s.l.



Maxillary palpus with 3 Pale bands, maxillary palpus with preapical dark band much longer than apical pale band



Leg entirely dark or with narrow apical pale bands or dorsal patches on some tarsomeres



Vein R₄₊₅ all dark

Anopheles dirus



DISTRIBUTION

Cambodia, China, Laos, Thailand, Vietnam

BIONOMICS

Immatures abundant in rainy season and found in several small, shallow shady temporary ground pools, animal footprints, puddles on foot paths, pools in dry stream beds, springs, streams, ground pools, wheel ruts, rock pools, bamboo stumps, and depressions in hollow logs.

MEDICAL IMPORTANCE

Primary vector of human Plasmodium parasites in forested and hilly-forested areas throughout its distribution range.

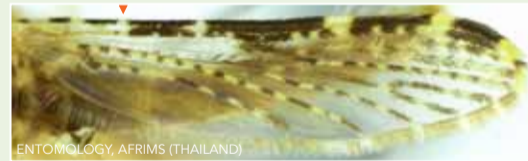
Anopheles dirus



Maxillary palpus with 4 or more pale bands



Tibio-tarsal joint of hindleg with large white band, hindtarsomere 4, 5 with obvious basal pale band



Accessory sector pale spot absent on costa and usually absent on subcosta, presector dark spot on vein R extending basally beyond presector dark spot on costa

Anopheles farauti s.l.



DISTRIBUTION

Australia, Indonesia, Solomon Islands (Santa Cruz Islands), Papua New Guinea, Solomon Islands, Bismark Archipelago, Vanuatu

BIONOMICS

Larvae are found in a wide variety of breeding places but prefer habitat with emergent, floating and submerged vegetation or algae in heavy shade. This species is also found in brackish pools, lagoons and mangrove swamps in costal areas. Larvae are occasionally taken from a wide variety of artificial containers. Adults feed on a wide variety of hosts, including man.

MEDICAL IMPORTANCE

Primary malaria vector.

Anopheles farauti s.l.



Maxillary palpus with 4 or more pale band. Proboscis all dark.



Hind femur, tibia, and tarsomere speckled with pale scales



Antepnotum with scales

Anopheles flavirostris



DISTRIBUTION

Indonesia, Philippines, Timor

BIONOMICS

Larvae are found in shaded and unshaded stream margins especially around roots, ground pools and shallow wells. Females feed on both man and cattle and readily enter houses to bite.

MEDICAL IMPORTANCE

Primary malaria vector.

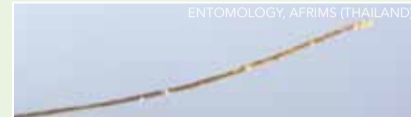
Anopheles flavirostris



Maxillary palpus with 3 pale bands apical dark band equal or shorter than apical pale band. Pale distal portion on ventral



Costa without presector pale spot and without humeral pale spot, vein M_{3+4} with two dark spots distal to mcu fork



Leg entirely dark or with narrow apical pale bands or dorsal patches on some tarsomeres



Antepnotum without scales

Anopheles fluvialitis



DISTRIBUTION

Afghanistan, Bahrain, Bangladesh, China, India, Iran, Iraq, Kazakhstan, Nepal, Oman, Pakistan, Saudi Arabia, Sri Lanka, Taiwan, Vietnam, Yemen

BIONOMICS

Not usually found below 1000 ft. Larvae are found in the grassy edges of slow moving streams, springs, irrigation channels, sometimes in the edges of swamps and lakes. Females readily bite man, feeding generally before midnight.

MEDICAL IMPORTANCE

Primary malaria vector.

Anopheles fluvialitis



Maxillary palpus with 3 Pale bands, maxillary palpus with preapical dark band much longer than apical pale band



Costa with out humeral pale and presector pale



Leg entirely dark or with narrow apical pale bands or dorsal patches on some tarsomeres



Anopheles harrisoni

ENTOMOLOGY, AFRIMS (THAILAND)



DISTRIBUTION

China, Laos, Vietnam, Myanmar, Thailand

BIONOMICS

Larvae found in small- to moderate-sized streams of clear, cool unpolluted water with partial shade and grassy margins. Other larval habitats include rock pools, sand pools next to streams, seepage pools and springs, stream pools and fallow rice fields with seepage. Females anthropophilic and endophagus.

MEDICAL IMPORTANCE

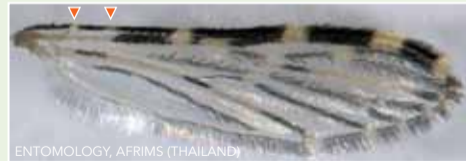
Malaria vector

Anopheles harrisoni

ENTOMOLOGY, AFRIMS (THAILAND)

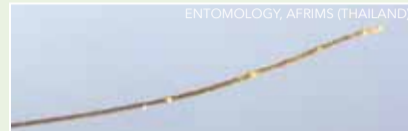


Maxillary palpus with 3 pale bands, apical dark band equal or shorter than apical pale band, proboscis all dark



Costa with presector pale spot and with humeral pale spot

ENTOMOLOGY, AFRIMS (THAILAND)



Leg entirely dark or with narrow apical pale bands or dorsal patches on some tarsomeres

Anopheles jeyporiensis



ENTOMOLOGY, AFRIMS (THAILAND)

DISTRIBUTION

Bangladesh, Taiwan, Thailand, Laos, Vietnam, Cambodia

BIONOMICS

Ground habitats with clear, cool, fresh water, slow moving or nearly stagnant with abundant emergent vegetation, and water temperatures in the 23 - 33C. range with 28C. as the ideal. Hill, mountain, high plateau species at elevations up to 1829m. seepage pools at the base of hills is the favored habitat

MEDICAL IMPORTANCE

Primary malaria vector. Found naturally infected with *B. malayi*W. *bancrofti*.

Anopheles jeyporiensis



Center of scutum covered with short oblong white scales extending back to scutellum



Foretarsomere 1 with apical pale band nearly 2.0 width of tarsomere diameter



Vein R1 usually with accessory pale spot on preapical dark (PD) area

Anopheles koliensis



DISTRIBUTION

Solomon Islands

BIONOMICS

Larvae found in temporary pools in grassland areas in full sunlight. Females are night biters and strongly anthropophilic.

MEDICAL IMPORTANCE

Primary malaria and periodic filiarasis vector.

Anopheles koliensis



Maxillary palpus with 4 or more pale bands, ventral pale scales present on apical third of proboscis



Hindfemur, tibia, and tarsomere speckled with pale scales



Anterpronotum with scales

Anopheles lesteri

DISTRIBUTION

China, Guam, Japan, Korea, Philippines

BIONOMICS

Larvae are found in cool shaded ground water habitats that include marshes, ground pools, ponds, rice fields and other impounded water. *Anopheles lesteri* populations reach their peak in August in Korea. Larvae are found in rice paddies, irrigation ditches, ground pools, stream margins and inlets, swamps and uncultivated fields.

MEDICAL IMPORTANCE

Important vector of malaria.



Anopheles lesteri



Hindtarsomeres with apical pale bands only.



Wing apex with narrow pale fringe spot, not extending beyond veins R_1 to R_3 , humeral crossvein without scales, pale fringe spot at vein CuA termination of wing absent.



Midcoxa without upper patch of pale scales.

Anopheles letifer



DISTRIBUTION

Cambodia, Indonesia,, Singapore, Thailand, Vietnam

BIONOMICS

Larvae found in still, shaded, dark, acidic water with emergent vegetation or numerous leaves in the water. Habitats include freshwater swamps, jungle pools, large isolated stream pools. Adults are exophagic night biters.

MEDICAL IMPORTANCE

Primary malaria vector in Malaysia.

Anopheles letifer



Palpus entirely dark scaled



Base of veins R and CuA with dark scales, wing apex with 2 pale fringe spots, without pale fringe spot at vein R₂, Vein 1A with pale scales proximal to median dark mark, or infrequently with 2 or 3 dark scales near base



Upper proepisternal setae absent on both sides

Anopheles leucosphyrus



DISTRIBUTION

Indonesia

BIONOMICS

Nothing is known about habitat of immatures (previous reports of larval habitats for this species actually refer to *An. latens*)

MEDICAL IMPORTANCE

Primary vector of human malaria parasites.

Anopheles leucosphyrus



Maxillary palpus with 4 or more pale bands, apical pale band on palpomere 5 distinctly cream-colored or yellowish



Tibio-tarsal joint of hindleg with large white band, hindtarsomere 4,5 without basal pale band



Accessory sector pale spot present on costa and subcosta, presector dark spot of vein R usually extending basally well onto level of humeral dark spot of costa, or beyond middle of humeral dark

Anopheles litoralis



DISTRIBUTION

Philippines

BIONOMICS

Larvae found in salt water fish ponds and lagoons.

MEDICAL IMPORTANCE

Malaria vector

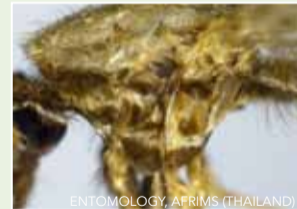
Anopheles litoralis



Legs conspicuously spotted: femora and tibiae of mid and hind legs and fore tarsus largely palescaled ventrally



Wing vein 1A with only two dark patches



Fossa of mesonotum with six to ten broad flat scales

Anopheles maculatus s.l.



DISTRIBUTION

Bangladesh, Cambodia, China, India, Indonesia, Laos, Malaysia, Taiwan, Thailand, Vietnam

BIONOMICS

Larvae found in hilly areas in seepage springs and small streams with some sunlight. Found frequently in recently cleared areas with disturbed soil. Adults primarily zoophilic.

MEDICAL IMPORTANCE

Primary malaria vector and a vector of *W. bancrofti*.

Anopheles maculatus s.l.



Hind femur, tibia, and tarsomere 1 speckled with pale scales, hind tarsomeres 3 and 4 not entirely white, entirely 5 white



VeinR₂₊₃ with one dark spot on both wings, and presector dark spot on vein R shorter than presector dark spot on subcosta and costa



Abdominal terga II-VI without pale scales, VII-VIII with broad spatulate pale scales

Anopheles minimus



DISTRIBUTION

Bangladesh, Cambodia, China, India, Indonesia, Laos, Malaysia, Pakistan, Philippines, Sri Lanka, Taiwan, Thailand, Vietnam

BIONOMICS

Larvae found in small- to moderate-sized streams of clear, cool unpolluted water with partial shade and grassy margins. Other larval habitats include rock pools, sand pools next to streams, seepage pools and springs, stream pools and fallow rice fields with seepage. Females anthropophilic and endophagus.

MEDICAL IMPORTANCE

Primary malaria vector.

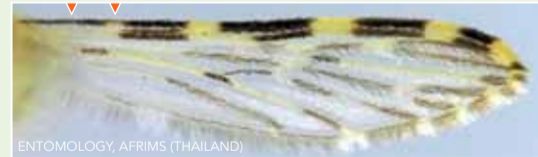
Anopheles minimus



Maxillary palpus with 3 pale bands, apical dark band equal or shorter than apical pale band, proboscis all dark



Leg entirely dark or with narrow apical pale bands or dorsal patches on some tarsomeres



Costa with presector pale spot and without humeral pale spot, vein M3+4 with two dark spots distal to mcu fork

Anopheles philippinensis



DISTRIBUTION

Bangladesh, Cambodia, China, India, Indonesia, Laos, Malaysia, Myanmar, Nepal, Philippines, Thailand, Vietnam

BIONOMICS

Larvae found in clean still or slowly moving water with vegetation. Habitats include grassy edges of rice fields, ponds, swamps and irrigation channels. Adults are zoophilic.

MEDICAL IMPORTANCE

Secondary malaria vector.

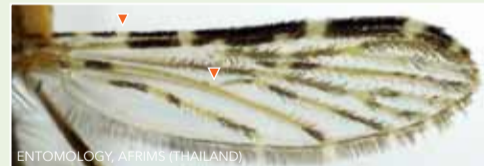
Anopheles philippinensis



Maxillary palpus with 3 pale bands



Hind femur, tibia, and tarsomere 1 dark, not speckled with pale scales, hind tarsomeres 3, 4 and 5 entirely white



Vein CuA mostly dark-scaled, without dark spot at fork with vein mcu, presector dark spot on vein R not reaching to distal end of humeral dark on costa

Anopheles pseudowillmori



DISTRIBUTION

India, Pakistan, Nepal, Myanmar, China, Laos, Thailand

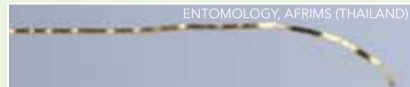
BIONOMICS

Larvae found in rice fields, stream margins, ponds, pit and wells.

MEDICAL IMPORTANCE

Malaria vector

Anopheles pseudowillmori



Hind femur, tibia, and tarsomere 1 speckled with pale scales, hind tarsomeres 3 and 4 not entirely white, entirely 5 white



Vein R_2 long, usually longer than twice length of vein R_{2+3} : furcation of vein R_{2+3} at the end of preapical dark spot on vein R_1



Abdominal terga II-VII without scales

Anopheles punctutatus



DISTRIBUTION

Australia, Indonesia, New Guinea, Islands west of Celebes and Timor, Melanesia, Solomon Islands

BIONOMICS

Larvae occur in small pools found after rains, streams margins sunlit rain pools.

MEDICAL IMPORTANCE

Malaria vector

Anopheles punctutatus



Maxillary palpus with 4 or more pale bands, proboscis with 1/3 or more apical pale



Broad pale scales on scutum, tergite VI, VII, VIII and sternite VII and VIII of abdomen, dark scales on knob of halter



Hindfemur, tibia, and tarsomere 1 speckled with pale scales



Broad pale scales on scutum

Anopheles sawadwongporni



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DISTRIBUTION

Bangladesh, Cambodia, India, Indonesia, Laos, Malaysia, Taiwan, Thailand, Vietnam

BIONOMICS

Larvae found in hilly areas in seepage springs and small streams with some sunlight. Found frequently in recently cleared areas with disturbed soil. Adults primarily zoophilic.

MEDICAL IMPORTANCE

Primary malaria vector and a vector of *W. bancrofti*.

Anopheles sawadwongporni



Hind femur, tibia, and tarsomere 1 speckled with pale scales, hind tarsomeres 3 and 4 not entirely white, entirely 5 white



Vein R₂₊₃ with two dark spots at least on one wing, if one then presector dark (PSD) spot on vein R usually as long as presector and costa



Posterolateral corners of abdominal terga II-VII with dark scales

49

Anopheles sinensis



DISTRIBUTION

Cambodia, China, India, Japan, Korea, Malaysia, Singapore, Taiwan, Thailand, Vietnam

BIONOMICS

Larvae are found in shallow habitats, fresh water usually with emergent vegetation and exposed to direct sunlight. They have been collected in ground pools, pools beside a river, marshes, stream margins, ditches, seepages, shallow ponds, and sumps. Larvae are sometimes collected in artificial containers. In mountainous areas they are confined to the valleys. Females are zoophilic and exophilic. *An. sinensis* is the most frequently collected species in August, September and October in Korea.

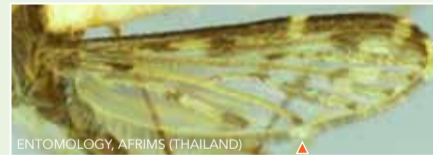
MEDICAL IMPORTANCE

Adults of *An. sinensis* have been incriminated as the natural and/or experimental malaria (*P. vivax*) vector in South Korea, Japan, China and Indonesia.

Anopheles sinensis



Clypeus with patch of dark scales on each side, pulpus with pale band



Wing apex with wide pale fringe spot, extending at least from vein R_2 to R_3 , preapical dark mark on vein R_1 with some pale scales, vein CuA with pale fringe spot



Hindtarsomeres with apical pale bands only



Midcoxa with upper patch of pale scales

Anopheles subpictus s.l.



DISTRIBUTION

Afghanistan, Bangladesh, Cambodia, China, India, Indonesia, Iran, Malaysia, Maldives, Mariana Islands, Myanmar, Nepal, Pakistan, Papua New Guinea, Philippines, Sri Lanka, Thailand

BIONOMICS

Larvae are typically found in muddy pools often near houses. Also found in barrow pits, buffalo wallows and artificial containers.

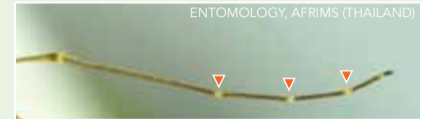
MEDICAL IMPORTANCE

Primary malaria in the Celebes but of minor importance elsewhere.

Anopheles subpictus s.l.



Maxillary palpus with 3 pale bands, maxillary palpus with subapical pale band 0.33 or less length of preapical dark band, which is 0.5 or more length of apical pale band



Hindfemur, tibia, and tarsomere all dark
Leg entirely basal and apical pale bands or dorsal patches on some tarsomeres

Anopheles sundaicus s.l.



ENTOMOLOGY, AFRIMS (THAILAND)

DISTRIBUTION

Bangladesh, Cambodia, China, India, Indonesia, Malaysia, Myanmar, Singapore, Taiwan, Thailand, Vietnam

BIONOMICS

A primarily coastal species, the larvae are found in sunlit brackish pools with algae. Adults bite primarily cattle but readily bite man indoors and out.

MEDICAL IMPORTANCE

Primary malaria vector.

Anopheles sundaicus s.l.



ENTOMOLOGY, AFRIMS (THAILAND)

Maxillary palpus with 3 pale bands



ENTOMOLOGY, AFRIMS (THAILAND)



ENTOMOLOGY, AFRIMS (THAILAND)

Leg entirely basal and apical pale bands or dorsal patches on some tarsomeres, hindfemur, tibia, and tarsomere 1 speckled with pale scales



ENTOMOLOGY, AFRIMS (THAILAND)

Antepnotum without scales

Anopheles willmori



DISTRIBUTION

Afghanistan, Pakistan,
India, Nepal, China,
Myanmar, Thailand

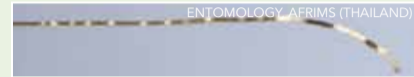
BIONOMICS

Larvae found in rice fields,
stream margins, ponds,
pit and wells.

MEDICAL IMPORTANCE

Malaria vector

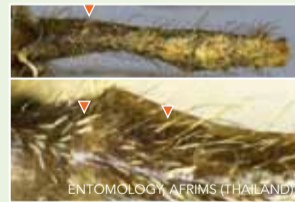
Anopheles willmori



Hind femur, tibia, and tarsomere 1
speckled with pale scales, hind tarsomeres
3 and 4 not entirely white, entirely 5 white



Vein R_{2+3} with one dark spot on both wings,
and presector dark spot on vein R shorter than
presector dark spot on subcosta and costa



Abdominal terga II-VIII largely
covered with broad spatulate
pale scales

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- Mr. Wachiraphan Chittham, Medical Research Technologist

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REFERENCES

Manguin, S., *et al.* (2008). Bionomics, taxonomy, and distribution of the major malaria vector taxa of Anopheles subgenus Cellia in Southeast Asia: An updated review. *Infection, Genetics and Evolution*, 8(4), 489-503.

O'Connor CT., *et al.* (1989). Illustrated Key to Female Anopheles of Indonesia. *Directorate of Communicable Disease, Ministry of Health, and US Navy Medical Research Unit*, 2.

Rattanarithikul R., *et al.* (2006) Illustrated keys to the mosquitoes of Thailand IV. Anopheles. *Southeast Asian J Trop Med Public Health* 37(Suppl 2):1-128.

Russell PF., *et al.* (1943). Keys to the anopheline mosquitoes of the world. *Am. Entomol. Soc., Acad. Nat. Sci., Philadelphia*, 152.

The Walter Reed Biosystematics Unit. PACOM Medically Important Mosquitoes. Retrieved October 2012 from <http://wrbu.si.edu/>