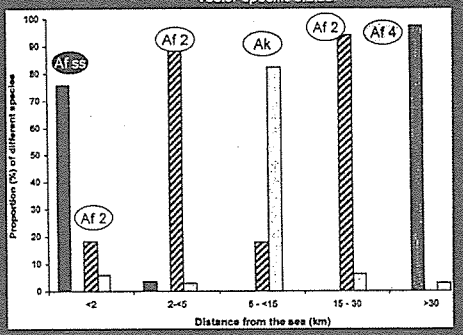
Distribution of the PCR-RFLP determined species of *An farauti* morphologic specimens at different locations from the sea in Papua New Guinea (Benet et al., 2004) Colored circles indicate vector-specific status



Morphological identification is unreliable

(Benet et al 2004)

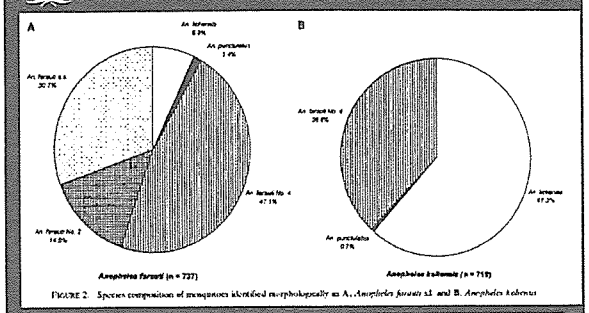


FIGURE 2. Species composition of mosquitoes identified morphologically as A, *Anopheles farauti* s.l. and B, *Anopheles koliensis*

PCR-RFLP used to verify morphological identifications

An. farauti species sub-complex & Infection status (Benet et al 2004: *Am J Trop Med Hyg*, 71(3), 277–28)

Sibling species	Ecotype	PV / PF CS # or rates	
		Madang (coastal: 0-5 km) N=583	Wosera (Inland: 15-29 km) N=12,516
An. farauti ss = Af 1	Coastal areas	5 / 0	0 / 0
An. hinesorum = Af 2	Coastal & inland areas	-	-
An. torresiensis = Af 3	Coastal & inland areas	-	-
An. farauti 4	Coastal & inland areas	3 / 1	-
An. farauti 5	Highlands	-	-
An. farauti 6	Highlands	-	-
An. farauti 7	Solomon Islands only	-	-
An. punctulatus	Coastal & inland areas	1 / 0	0.4% / 1.1%
An. koliensis	Coastal & inland areas	2 / 1	0.2% / 0.1%

Late biting habit of parous Anopheles & pre-bedtime exposure to infective mosquitoes (Bockarie et al 1996)

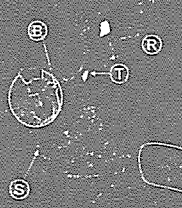
Table 3. Proportion of female *Anopheles farauti*/*koliensis* infected with *Plasmodium falciparum* and *Plasmodium vivax* in hourly biting populations from 18:00 to 06:00 in six villages in East Sepik Province of Papua New Guinea

Time	Number of mosquitoes processed	Infected with *P. falciparum*	Infected with *P. vivax*
18:00–19:00	82	0 (–)	2 (2.4%)
19:00–20:00	130	0 (–)	2 (1.5%)
20:00–21:00	140	1 (0.7%)	1 (0.7%)
21:00–22:00	183	3 (1.6%)	2 (1.1%)
22:00–23:00	317	9 (2.8%)	3 (0.9%)
23:00–00:00	401	10 (2.5%)	6 (1.5%)
00:00–01:00	461	9 (2.0%)	6 (1.3%)
01:00–02:00	615	2 (0.3%)	1 (0.2%)
02:00–03:00	461	8 (1.7%)	7 (1.5%)
03:00–04:00	460	10 (2.2%)	5 (1.1%)
04:00–05:00	397	10 (2.5%)	6 (1.5%)
05:00–06:00	521	14 (2.7%)	2 (0.4%)
Total 18:00–06:00	4168	76 (1.8%)	43 (1.0%)

1. Significantly higher prop (11.6%) of Anophs infected Pv caught in 1800-2100 h)
2. Anophs infected with Pv tend to bite earlier than Pf infected
3. Mosquitoes with Pv sporozoites younger than Pf –sporozoite infected [Pv sporogony 7 d < Pf 9 d at 30°C
4. Tendency for younger parous females to bite earlier than older ones explain early biting habit of Anophs infected Pv
5. Implications on impact of ITNs

Role of Ap group in *vivax* transmission

Country, author	CS rate Pv/Pf %	EIR (Pv)	Malaria control intervention
Saundaung, PNG (Attenborough et al 1997)	Ak 0.76 / 0.57	0.03 – 0.91	CS + rates ↑ with ↑ altitude (170-150 m asl)
Buka, PNG (Cooper & Frances 2002)	Af 0.69 / 1.73	NA	Cessation of DDT spraying (1961 baseline)
Wosera, PNG (Hii et al 2000; 2001)	Ap 0.25 / 0.75 Ak 0.42 / 0.82 Kar 0.10 / 0.40 Af 0.12 / 0.18)	10.9 inf bites/p-year (Pf: 35.4)	Cessation of DDT spraying Untreated bednets
Makile-Vutu, Guadal. SI (Hii et al 1995)	Af 0.32 / 0.6	0.69-0.93	No vector control
Ghogodo Tumorora, SI	Af 0.11 / 0.21	0.29-0.34	DDT indoor spraying
Keamanu Tanabita, SI	Af, Ap 0.2 /0.065	0.031-0.152	Permethrin ITN



Western Pacific Region

1. Forested & hilly areas (complexes. *An dirus, An. minirhus, An. balabacensis, latens, leucosphyrus*)
2. Subsistence agriculture in forested areas, forest fringe & transition areas, temporary migrants, plantation workers & organised migrants, large population groups and border areas, highland fringe. Complexes. *An. minimus, maculatus, An. flavirostris*)
3. Coastal: *An. sundaicus complex, litoralis*
4. Rice fields: *An. sinensis, An. anthropophagus, aconitus*

Links between malaria transmission & forests (Guerra et al 2006)

Vector type	Region	
	South-east Asia	Western Pacific
Deep or closed forest*	*An. dirus* ® complex	*An. balabacensis* ® *An. leucosphyrus* ® *An. dirus s.s.* ® *An. latens* ® *An. baimaii* ® *An. donaldi* ® *An. flavirostris* ®
Near- or non-forest #	*An. culicifacies* ® complex *An. fluviatilis* ® *An. minimus* ®	*An. farauti* ® complex *An. koliensis* ® *An. punctulatus* ® *An. letifer* ® *An. maculatus* ® complex *An. minimus* ® complex

*Deep-forest vectors – require deep shade for breeding
® Considered a main vector (dominant & widespread) throughout its range
Non-forest or forest-fringe species are seldom, if ever, implicated in deep-forest transmission

Leucosphyrus Group

7 important vectors of forest malaria:

An. latens (=An. leucosphyrus sp A)
An. baimaii (=An dirus D)
An. balabacensis s.s.
An. dirus s.s (=An. dirus A)
An. leucosphyrus s.s. (=leuco sp B)
Probably An. cracens (=An. dirus B)
Presumably An. scanloni (=An. dirus C)
Perhaps An. elegans (=An. dirus E)
An. hemiphilus (=An. dirus F)

Ref: Sallum et al 2002; Med Vet Entomol 16: 158-199

An. leucosphyrus group – biology & behaviour (after Meek 1999): a complex of 9 sibling species

Resting location	Feeding time / location	Host preference	Flight range	Breeding sites	Longevity
Mainly out (exophilic)	Mainly late (or 20:00-02:00 h), out an in	Mainly man	1-5 km	Small shady pools mainly in forest & plantations, footprints, stream seepages, wheel ruts, gem pits, hollow logs, sometimes wells	High

- Refractory to DDT / IRS (Ismail et al 1974, 1975); vectorial capacities of *dirus* were reduced but this effect was not maintained and malaria transmission not interrupted
- Response to ITN – positive and neutral results on malaria disease indicators. Human behaviour factor ('exophilic people' among exophilic vectors)
- *dirus* A – early biting, exophily & exophagy not ideal for ITN & IRS

Transmission indices of *An. dirus* A, (Trung et al 2004; Vythilingam et al 2005) & *An. leucosphyrus* (Chang et al 1999)

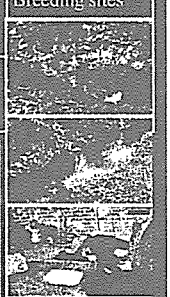
Country, year	Pf / Pv CS rate # (%)	Annual EIR	Malaria incidence
Viet Nam – Lang Nhot, 1998	1 / 1 (1.1%)	1.095	0.630 attacks/man/yr
Viet Nam – Village 3, 2000	0 / 3 (1.2%)	1.095	0.220 attacks/man/yr
Cambodia – Cha Ong Chan, 1999	1 / 2 (10.7%)	5.207	45% (parasite rate)
Sarawak, Malaysia – Belaga district	2 / 2 (0.27%)	NA	Pv: 9.5% (farm huts); Pv: 0.28% (villages)
Attapeu province, Lao PDR, 2002-04	na / na (0.99%)	0.05	Pv: 3.09-6.17% (wet) Pv: 1.31-3.91% (dry)

Malaria transmission is perennial in VietNam & Laos; EIR highest in transition/dry season (Laos) & post monsoon/dry season (Thailand)

An. minimus – biology & behaviour, a complex of 4 sibling species (after Meek 1999)

Resting location	Feeding time / location	Host preference	Flight Range
Mainly out (previously in)	All night, mainly out (previously in). Sp A is a late biter	Man & cows,	1-3 km

Breeding sites

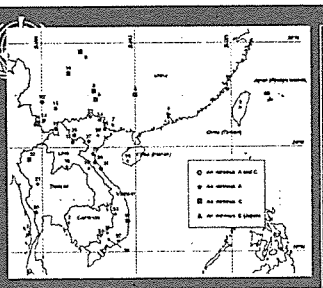


Response to DDT – eliminated in Nepal, populations reduced in peninsula & central Thailand, but abundant in hilly forests (Garros et al 2006); vector nearly eliminated in Ban Phluang, SE Thailand
Impact of ITN – no general reduction of vectorial capacity of *minimus* A and *maculatus* group; lack of mass effect (Somboon et al 1995); good response in VNam (sp A is a late biter)

Transmission indices of *An. minimus* A

(Trung et al 2004; Garros et al 2006; Sithiprasasna et al 2003)

Country, year	Pf / Pv CS rate # (%)	Annual EIR	Malaria incidence
Viet Nam – Lang Nhot, 1998	7 / 3 (2.8%)	58.25	0.630 attacks/man/yr
Cambodia – Cha Ong Chan, 1999	1 / 0 (1.4%)	0.767	45% (parasite rate)
Thailand – Mae Sot, 2001-2002	1 / 8 (0.22%)	0.028 (wet) 0.01 (dry)	NA



Vector competence of Sp C
(Garros et al 2006)

- Sp C less competent vector than sp A; more exophagic
  Need to determine vectorial status as it is conspecific with *An. fluviatilis* S recognized as as an efficient vector in India
- Sp C suspected to transmit malaria in southern China and Thailand where it is the main species of the complex
- Sp E not incriminated as a vector, Ryukyu is malaria-free

Role of *An. minimus sl* in malaria transmission

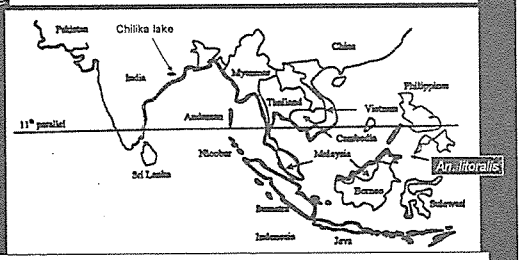
1) Assam (India), 1990 – sporozoite infections all year round except Aug/Sep
2) Yunnan province, China – main vector, sporozoite rate 7.05% (Dong, 1997)
3) Gia Lai, C VietNam – sporozoite rate 7.05% (Phan 1998)
4) Myanmar – main malaria vector (Oo et al 2004)

Role of potential vectors

A number of studies showed that potential malaria vectors often contribute considerably to malaria transmission after environmental changes, which could shift their feeding more towards humans and favour their survival, hence increasing their vectorial status

Examples – 1) disappearance of sundaicus (India), role of *An. subpictus* complex (also a coastal vector) & 2) *An. annularis, campestris*

Distribution of *An. sundaicus* complex
(after Dusfour et al 2004; Dash et al 2000)



1. Coastal areas marked in black – currently recognized distribution
2. Gray zones – *sundaicus* reportedly disappeared (red spot Chilika Lake)
3. Uncolored areas – species is absent or has never been recorded
4. Environmental changes – Peninsular Malaysia, India, S Viet Nam

An. sundaicus – biology & behaviour (after Meek 1999), a complex of 4 sibling species

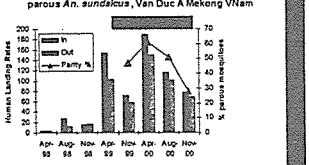
Resting location	Feeding time / location	Host preference	Flight range	Breeding sites	Longevity
Outdoors and indoors	All night, peak 8-12 pm, out & in	Man & Domestic animals	5 km	Coastal brackish to Freshwater Rockpools, River mouths, deltas	Low

1) *An. sundaicus* sp A formally named as *An. epiroticus*
2) Mekong delta, VietNam – changes in land use from rice cultivation to shrimp farming favours *sundaicus*
3) Decreasing malaria endemicity → reduction of *sundaicus* vectorial capacity and to the disappearance of *An. subpictus*, secondary vector.

References:
Trung et al: TMIH 9: 230-7
Erhart et al: TMIH 9: 1081-1090

- 1960-1975: sporozoite rates of *A. sundaicus & A. subpictus* range: 0.2% and 2.4%
- Early 1990s – sporozoites found in both spp similar coastal area near HCMC
- Low parity rate decreased by 40% between Nov 1999 & Nov 2000
- Density of sundaicus >50x between Apr 1998 and Apr 2000, but *subpictus* (whose density was 3x higher than *sundaicus* in Apr 1998) disappeared completely after Apr 1999.
- Opposite density dynamics of 2 vectors related to socio-economic development

Indoor & outdoor human landing rates and % parous *An. sundaicus*, Van Duc A Mekong VNam



Observed sporozoite rate = 0/11 002;

Calculated sporozoite rate = 1/300 000 (using the entomological risk equal to the malaria incidence).

Entomological risk = 0.0

Malaria incidence= 0.019 attacks/man/year

Susceptibility of *Anopheles* spp collected in Mae Hong Song Prov to local strains of PV (Somboon et al 1994)

Anopheles	Carrier no	No. positive with oocyst/no. dissected	Mean no. of oocyst (range)	No. positive with sporozoite/No. dissected
Vagus	PV1	5/5	6.6 (3-11)	3/3
Kochi	PV1	1/1	47.0 (47)	NA
	PV2	5/6	59.8 (2-135)	2/3
Annularis (Nepal & Myanmar)	PV1	4/4	9.3 (2-30)	NA
	PV2	3/3	45.0 (21-65)	5/7
Minimus A	PV1	2/3	10.0 (9-11)	1/1
	PV2	2/2	32.0 (25-39)	3/3
Sawadwongporni	PV1	1/1	12 (12)	2/2
Willmori (Nepal)	PV1	1/2	5 (5)	1/1
Sinensis (China)	PV2	5/6	28.2 (1-101)	8/13
Barbirostris (Indonesia)	PV1	1/1	7 (7)	NA
	PV2	4/5	12.3 (5-22)	2/3
Campestris (Malaysia)	PV3	31/50	28.2 (1-98)	12/50

Potential of *An. barbirostris/campestris* group

A two-year entomological study in Sa Kaeo Thailand (1998–1999) showed that a decrease in the abundance of *An dirus*, the main *Pf* vector, was accompanied by a concurrent increase in the abundance of members of the *barbirostris/campestris* group.

Might be important secondary vectors

High fecundity = 173 – 311 eggs /female

High indoor / outdoor biting = 9 / 4 bites/p-h

High anthropophily = 78.6% (human); 7.1% (cow)

Susceptibility to only *P. vivax*

Ref Apiwathnasorn et al 2002. J Med Ent 39: 583-586

Research gaps

Information required for strategic planning of control programs:

† Where does malaria transmission occur?
† When does malaria transmission occur (seasonal or year-round transmission)?
† What species of *Plasmodium* is the causative agent for malaria?
† What is the prevalence of *Plasmodium vivax* (VK210/247)?
† Who is the population at risk?
† What is the interaction between *P vivax* and vectors?
† Which mosquito species is the main vector(s) of malaria transmission?
† What are the responses to ITN (or LLINs) and IRS?
† What is the insecticide sensitivity status of the malaria vector(s)?
† What is the distribution, ecology and human-vector contact of sibling species of *Ap* group in Solomon Is, Vanuatu, Irian Jaya and Moluccas?
† What is the role of *minimus* C in malaria transmission?
† What is the role of secondary vectors in changing or modified environments, eg deforestation

Malaria Control in China
中国疟疾控制

Division of Schistosomiasis Prevention and Management
Department of Disease Control
Ministry of Health P. R. China
卫生部疾病预防控制局血防处

Contents 主要内容

- Historical Epidemic Situation历史流行情况
- Current Malaria Endemic Situation当前疟疾流行形势
- Recent national control activities and Plans 国家疟疾防治规划

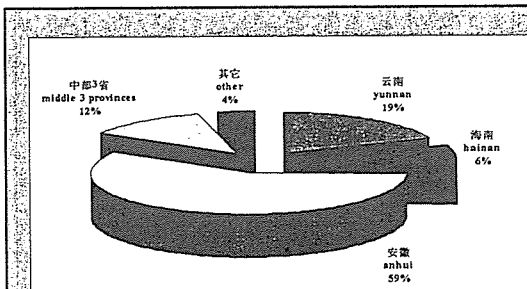
Historical Epidemic Situation
历史流行情况

- In 1940's, more than 30 million people were infected by malaria. The mortality rate is 1% for each year. 20世纪40年代，我国每年至少有3000万以上患者，病死率约为1%。
- In early 1950's, there were 1829 endemic counties in China, accounting for 80% of the total counties. 20世纪50年代初期，全国有1829个县疟疾流行的，约占全国总县数的80%。
- In 1960's and 1970's, two malaria pandemics occurred in the central part of China (plains of Yellow river and Huaihe river). The number of infected people reached 17 million and 21 million respectively. 20世纪六十和七十年代，黄河和淮河平原曾经两次发生疟疾大流行，发病人数分别高达1700万和2100万。

Three stages of malaria control in China
中国疟疾控制的3个阶段

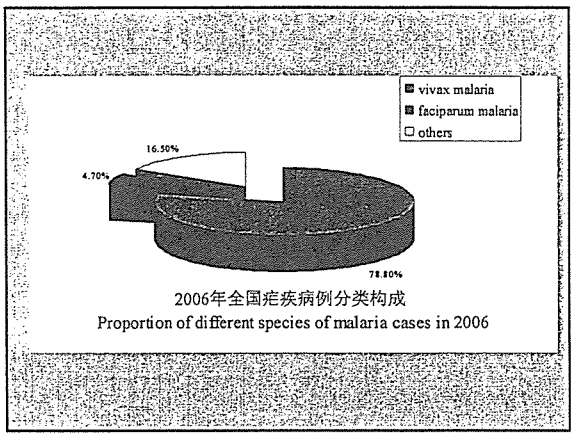
- 1950's — Base-line investigation: To investigate the endemic degree, endemic area, character of vectors, carry out pilot study for the control activities.调查摸底阶段:摸清流行程度、范围、媒介，开展防治试点研究。
- 1960-1990's— Intensive prevention and control: To implement comprehensive malaria control program according to different vectors and prevalence in different period.全面开展疟疾防治阶段：各地因地制宜地采取综合性防治措施。
- After 1990's — Surveillance:监测阶段:
  - South provinces: continue implement malaria control programme 南方各省继续强化疟疾防治。
  - Other provinces: strengthen surveillance 其他省转入监测

Current malaria endemic situation
当前疟疾流行情况



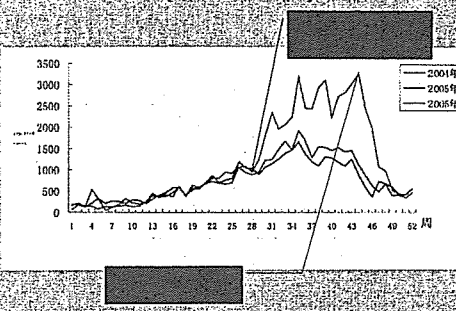
2006年分地区发病构成比
Proportion of malaria cases in different parts of China in 2006

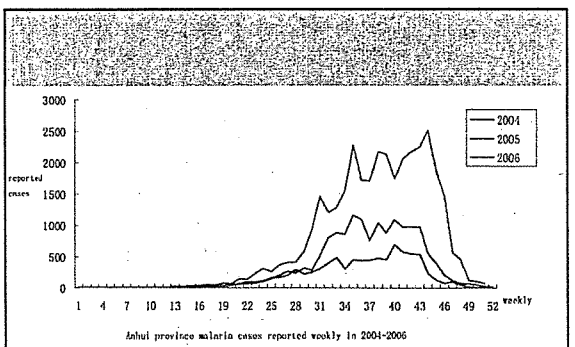
Currently, the endemic area are major in the south and middle of China (Yunnan, Hainan, Hubei, Henan, Anhui, Jiangsu) 疟疾流行主要在中部和南方6省



2006年全国疟疾病例分类构成
Proportion of different species of malaria cases in 2006

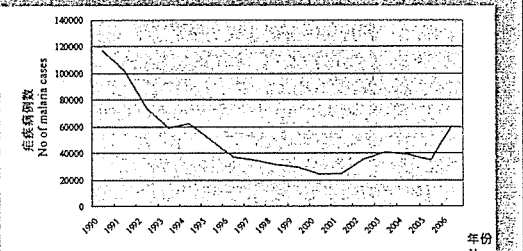
malaria weekly reported cases (2004-2006)





Anhui province malaria cases reported weekly in 2004-2006

Malaria endemic Trends 疟疾流行趋势



1990-2006年全国疟疾疫情趋势图
National Malaria Situation trend from 1980-2006

Current malaria endemic situation(2) 当前疟疾形势

Reasons for the increase 疟疾回升的主要原因

- National infection diseased reporting system have been strengthened国家疫情报告系统的加强
- Malaria imported cases increased by people's migration (especially along the bordering areas of Yunnan province)流动人口疟疾问题
- Malaria reemerging in the central part of Anhui and Henan provinces 中部以安徽为重点的沿淮河流域疟疾回升

Main Problems (1) 存在的主要问题

1. Poor access to accurate diagnosis and appropriate treatment 不能获得正确的诊断和治疗
   - → One-third of the township hospitals in malaria endemic areas cannot perform blood examination 1/3的乡镇卫生院不能开展血检
   - → No more than 10% of patients receive prompt diagnosis and proper treatment at village clinics 在村卫生室获得及时诊断和正确治疗的病人不到10%
2. Low coverage of anti-relapse and pre-transmission season treatment 休止期治疗覆盖率低
3. Drug resistance 耐药性
   - → *Falciparum* malaria exhibit resistance to a broad range of antimalarials including chloroquine, amodiaquine, piperaquine and pyrimethamine. 恶性疟对很多药物耐药

Main Problems (2) 存在的主要问题

4. Low coverage of vector control measures 控制媒介措施覆盖率很低
   - → Bednets ownership: about 50% 蚊帐覆盖率在50%左右
   - → ITN ownership: below 5% 药浸文章覆盖率低于5%
5. Weak surveillance and inadequate capacity for outbreak response 监测和应急处理能力弱
   - → Less than 5% of outbreaks are properly controlled within 2 weeks of onset 暴发疫情在2周内及时处理率不到5%
6. Low malaria awareness 疟疾知识知晓率低
   - → Awareness related malaria in residents: only 16%; 居民知识知晓率只有16%
   - → Awareness related malaria in students: 36% 学生知识知晓率36%

National Malaria Control Plan (NMCP) 国家疟疾控制规划

The National Malaria Control Plan（2006-2015）" started in 2006
《2006--2015年全国疟疾防治规划》于2006年开始实施

Goal : by 2015
- Control malaria in Yunnan Province (incidence <0.1/1000)
- Eliminate falciparum malaria in Hainan province (incidence <0.01/1000)
- Eliminate malaria in other areas of China

目标：到2015年
- 云南省控制疟疾流行（发病率<0.1/1000）
- 海南省消除恶性疟(发病率 <0.01/1000)
- 全国其它地区基本消除疟疾

Strategy 控制策略

- *People in remote areas have better access to malaria preventive measures. 使边远地区居民得到更有效的疟疾预防措施*

→ Free provision of LLIN (long-lasting bednets)免费提供长效药物浸泡蚊帐

→ITNs (retreatment for existing conventional nets) 现有蚊帐免费药物浸泡

Strategy 控制策略

- *People in remote areas have better access to timely diagnosis and appropriate treatment in the public and private sectors. 使边远地区居民得到及时诊断与规范治疗*

→Strengthen microscopy system in township hospitals 加强乡镇卫生院显微镜镜检

→Free provision of RDTs in remote *P.f* endemic areas 在偏远恶性疟流行区提供快速诊断试纸条

→Provision of appropriate anti-malarials treatment 提供免费抗疟药进行规范治疗

Strategy 控制策略

- *Strengthen malaria surveillance and epidemic preparedness and response 加强疟疾监测，提高暴发流行应急反应能力*

→Strengthen surveillance and routine case reporting 加强疟疾监测和疾病报告

→Provide equipment, RDTs and insecticide for outbreak control 加强暴发流行应急反应处理能力

→Strengthen border checks and improve cooperation with neighboring countries 加强毗邻国家的合作交流

Strategy 控制策略

- *Increase community awareness and demands for effective malaria treatment and prevention. 提高社区居民有效预防和治疗疟疾的意识和需求*

→Develop IEC/BCC methodologies and materials 根据不同对象设计开发健康教育材料

→Implement IEC/BCC activities through a broad range of players 针对不同人群，通过各种渠道、多部门参与进行健康教育


Roll Back Malaria
Work together
遏制疟疾
共同努力
Thank you.

Entomological Factors Affecting *Vivax* Malaria Transmission in China

Zhou Shui-sen

January 16, 2007

Vivax malaria in China

- *Plasmodium vivax* is the predominant species in China, all the malaria areas have *vivax* transmission. Only Yunnan and Hainan provinces have *falciparum* malaria transmission locally, even in these two provinces the proportion of *vivax* malaria is also up to 80%.

Vivax malaria in China

- In recent years the re-emergence and epidemic of *vivax* malaria is the crucial problem in China especially in central provinces. The reasons of malaria coming- back are complicated, besides the existence of *Plasmodium vivax* with long incubation period, vectors play very important roles in malaria transmission.

Main vectors transmitting *vivax* malaria in China

- Currently 4 species of mosquitoes are the major transmitting vectors in China, they are:
  - ***---Anopheles sinensis***
  - ***---Anopheles anthropophagus (lesteri)***
  - ***---Anopheles minimus***
  - ***---Anopheles dirus***

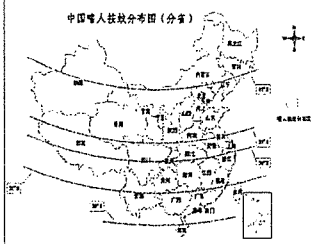
Geographical distribution of different vectors in China

- Generally *An. anthropophagus* and *An. sinensis* are the major transmitting vectors in the central provinces, while *An. minimus* and *An. dirus* are key malaria vectors in Yunnan and Hainan provinces.

Geographical distribution of different vectors in China

- *An. sinensis* extensively distribute in the country except for a few provinces such as Xinjiang Autonomous Region and Qinghai Province.
- *An. minimus* mainly distribute in Southern parts of 33℃North latitude, especial in parts of 25℃North latitude, it is the major vector in Southern provinces.
- *An. dirus* limitedly distribute in hilly and forest areas in Hainan and Yunnan Provinces.

Need to be specially mentioned is the geographical distribution of *An. anthropophagus*, newly researches find that the scope of this mosquito has extend northward from South 33℃ to 42℃ of North latitude partially because of the global warming. From the this map we can see *An. anthropophagus* was found in Liaoning Province, while in the past we thought no this mosquito exist in these areas.



Feeding and resting behavior

- It has been found that *An.sinensis* can rest in both animal sheds and human house. Regarding feeding and resting behaviour, it seems that *An.sinensis* is neither a typical exophagic and exophilic nor typical endophagic and endophilic malaria vector.
- Indoor and outdoor human biting rate of *An.sinensis* is about equal in China.

Feeding and resting behavior

- The endophilic and anthropophilic habits of *An. anthropophagus* are very typical in the past, but latest findings showed that the resting behaviors of *An. anthropophagus* in different areas are distinctly different. In the Southern and central parts they are endophilic, while in the Western and North parts they are exophilic.
- The human blood index is up to 0.677～0.892 in Southern and central parts while only 0.125 in the North provinces (such as Liaoning).

Feeding and resting behavior

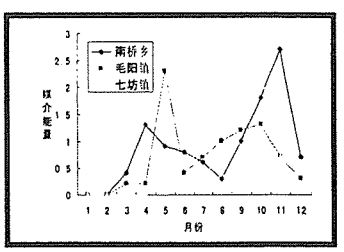
- *An.minimus* is considered to be highly anthropophilic. From this map we can see the proportion of biting human is much higher than that of biting cattle, but in recent years it was found that the proportion of biting cattle increased.

An. dirus is also anthropophilic but typical exophagic, it normally be found in stone holes and small forest.

Vectorial capacity

- It has been proven that the vectorial capacity of *An. anthropophagus* is 11-20 times higher than that of *An. sinensis*. Need to be mentioned, although the vectorial capacity of *An. sinensis* is relatively low, they still play an important roles in recent re-emergence of *vivax* malaria in central provinces because of its big population.

This slide showed the vectorial capacity of *An. Dirus* based on studies in Hainan, its capacity is near 3.0 with two season peaks.



Vectorial Capacity of *An. dirus* in Hainan

Entomological factors affecting *vivax* malaria transmission

- Different malaria vectors distributing in the similar areas made vector control measures more difficult and less effective.
- *An. sinensis* is still a very important vector transmitting *vivax* malaria in central provinces because of its extensive distribution and big population. In recent years according to annual reporting system, most of malaria cases are found in areas where *An. sinensis* is only vector.

Entomological factors affecting *vivax* malaria transmission

- Change of ecological environment and global warming made northward spread of *An. anthropophagus,* the density of the vector mosquito increased obviously and the mosquito was found in many new areas (such as Liaoning, Shandong), which posed higher risk for malaria transmission and epidemic.

Entomological factors affecting *vivax* malaria transmission

- Genetic variation of mosquitoes made malaria vector more complicated. Studies have confirmed that a particular malaria vector is not a single species but a complex or group with different biological characters and behaviors. For example:

Entomological factors affecting *vivax* malaria transmission

- Molecular biology researches have found that *An. ninimus* is a complex consists of sibling species A and C in China, and their importance and differentiations in malaria transmission need further studies.
- *An. dirus* was also found different sup-species including species A, B,C, D.

Entomological factors affecting *vivax* malaria transmission

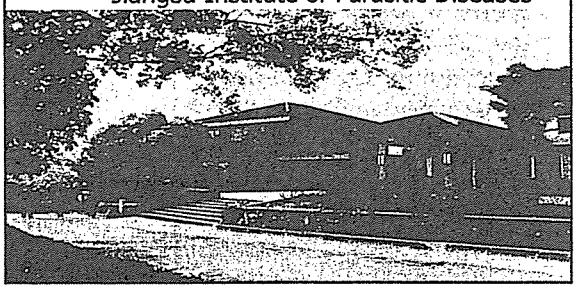
- Changes in feeding and resting behavior make some measures such as indoor residual spray less effective in some areas.
- Although no enough evidence showed resistance of malaria vectors to existing insecticides, small scale investigation found *An. sinensis* exist resistant to permithrin.

Thank you for your attention

Vivax malaria treatment in China

Prof.Gao Qi

Jiangsu Institute of Parasitic Diseases



1. The operational test for vivax malaria treatment

There were many operational tests for vivax malaria treatment with C/P carried out during 1970's and 1980's and different dosages of Primaquine were tested at that time.

Areas	Dosage/day	No. of cases	Survey period (month)	Clinical relapse		Relapse with parasite	
				No. of cases	%	No. of cases	%
Shanghai	210mg/14d	58	9	0	0	0	0
Shanghai	157.75mg/7d	31	8	0	0	0	0
Shanghai	112.5 mg/5d	39	8	0	0	1	3
Shanghai	105mg/7d	38	8	0	0	0	0
Shanghai	90mg/3d	15	8	1	7	1	7
Shanghai	75mg/5d	8	8	1	13	1	13
Hainan	210mg/6d	63	4	0	0	2	3
Guizhou	210mg/14d	13	12	0	0	2	15
Guiyzhou	100mg/5d	102	12	1	1	15	15
Henan	67.5mg/3d	14	11	3	21	5	36

1.1 The results shown that the treated time was not less than 5 day and the total dosages of Primaquine was not less than 135 mg.

1.2 However, even the same dosage (210mg/14d) used in different malaria endemic areas the results were different.

Areas	Dosage/day	No. of cases	Survey period (month)	Relapse with parasite(%)
Hainan (high epidemic)	210mg/14d	210	3	27
Shanghai (low endemic)	210mg/14d	106	3	0

2. Operational test for reducing relapse of vivax malaria with different dosage of Primaquine

Dosage/d Treated times	Interval times (month)	No. of cases	Survey period (month)	Relapse (%)	Side-reaction	
					Normal	Cyanosis
210mg/7d 2 times	4	71	3	0	19	26
180mg/8d 2 times	1	192	3	0.5	1	15
120mg/4d 2 times	0.5	91	5	3.3	0	2
210mg/7d Single time	/	83	4.5	6.0	1.3	17

Normal side-reaction: Anorexia,Nausea,Vomiting et al.

2.1 The results shown that the 2 times treatment of Primaquine were better than single treatment.

2.2 Comparison with relapse and side-reaction, 180mg/8 days and 120 mg/ 4 days 2 times treatment were better than others. It would be suitable for a large scales performance in endemic areas.

3. Operational test in comparison with different 8 days treatments of Primaquine

- The operational test carried out in Jiangsu province from 1990 –1993.
- The C/P 8 days treatment:
  Chloroquine: 1.2 g(3 days)
  Primaquine: 180mg(8 days)
- The double C/P 4 days treatment:
  Chloroquine: 1.2 g(3 days)
  Primaquine: 90mg(4 days) plus 90mg(4 days) within 1 month

Double C/P 4 days			Single C/P 8 days		
No.of cases	No.of relapse	Relapse rate(%)	No.of cases	No.of relapse	Relapse rate(%)
125	4	3.2	88	3	3.4

3.1 There were no different for relapse rate between the C/ P 8 days treatment and C/ P double 4 days treatment.

- The side-reaction of C/ P double 4 days treatment were less than C/ P 8 days treatment.

4. The Principle and Scheme for vivax malaria treatment in China

4.1 Eight days regimen of chloroquine plus primaquine

- Total dosage of 1.2g Chloroquine plus 180mg Primaquine:
  - 0.6g chloroquine for the first day,
  - 0.3g chloroquine daily for the next 2 days.
  - 22.5mg Primaquine daily for 8 consecutive days administered with chloroquine simultaneously from the first day.

4.2Different dosage of chloroquine between China and WHO recommendation

WHO (150mg/table)				China (150mg/table)			
Total	D1	D2	D3	Total	D1	D2	D3
10 (1.5g)	4 (0.6g)	4 (0.6g)	2 (0.3g)	8 (1.2g)	4 (0.6g)	2 (0.3g)	2 (0.3g)

4.3Different dosage of primaquine between China and WHO recommendation

WHO (7.5mg/table)		China (7.5mg/table)	
Total	**Days (14)**	**Total**	**Days(8)**
28tables (210mg)	2 tablets (15mg) / day for 14 days	24tables (180mg)	3 tablets (22.5mg) / day for 8 days

5. Radical cure of vivax malaria

- Due to the frequent relapse of vivax malaria, there are a Radical cure(8 days of primaquine)for vivax malaria cases in next spring season(no-transmission period) in China.
- The dosage of Radical cure in next spring season is primaquine 22.5mg/day for 8 days.

7. Chemoprophylaxis in transmission season

- Piperaquine has been used for Chemoprophylaxis in target group or target areas in transmission season
- Piperaquine: 4 tables for one month

6. The needed operational research

6.1 chloroquine resistant on vivax malaria

- There is no laboratory data of vivax malaria resistant with chloroquine in China before 2005.
- One research carried out in 2005-2006 and some suspected chloroquine resistant vivax malaria were found in middle part of China

6.2 Appropriate dosage and time for vivas malaria treatment in temperate areas

- Although 8 days c/p treatment carried out in China for many years, there is no scientific documentation to compare 8 days c/p treatment with 14 days C/P for efficacy and side-effects of primaquine

6.3 New RDT suitable for vivax malaria diagnosis

- Also many RDT products on the market most of them for falciparum malaria
- Few of RDT products is suitable for vivax
- It is need for develop the New RDT suitable for vivax malaria diagnosis

6.4 New technique for detection of G6PD absence

- G6PD absence is the major problem for implement mass chemoprophylaxis with primaquine in vivax malaria areas
- The ratio of G6PD absence is very low in major vivax malaria areas in China as well as in POK and DPRK
- So, It is needed to develop the new technique for detection of G6PD absence

Surveillance and Early Warning System for Vivax Malaria in China

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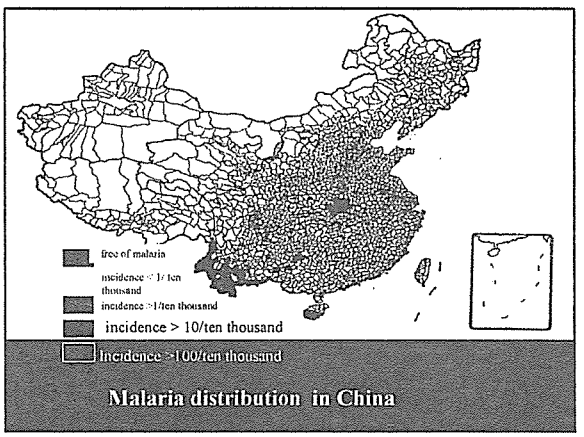
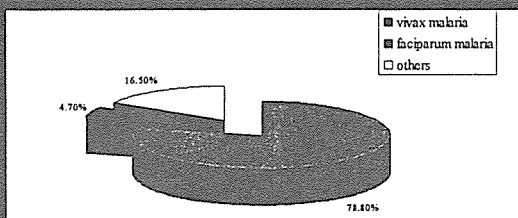
National Institute of Parasitic Diseases, China CDC
(WHO Collaborating Center for Malaria, Schistosomiasis and Filariasis)

中国疾病预防控制中心

CHINESE CENTER FOR DISEASE CONTROL AND PREVENTION

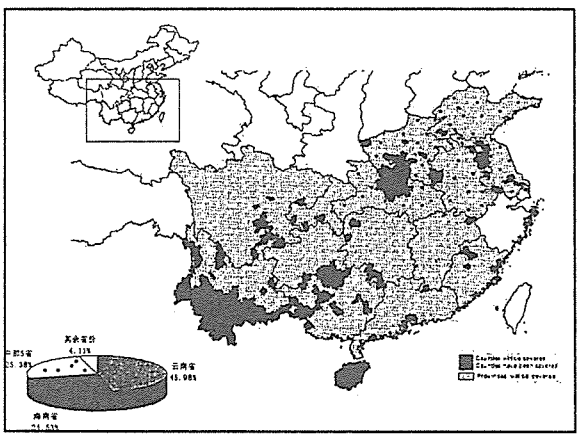


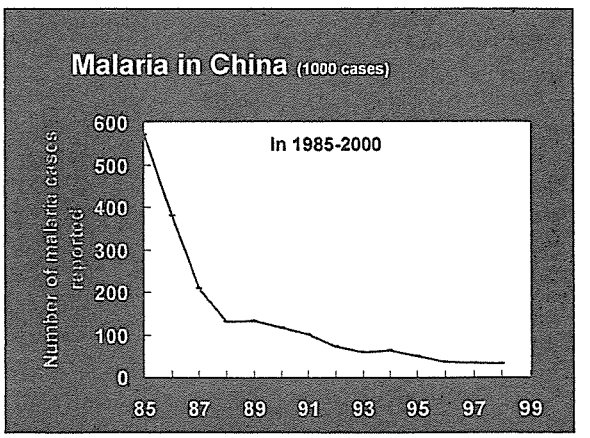
Malaria distribution in China



2006年全国疟疾病例分类构成

Proportion of different species of malaria cases in 2006





Since year 2000: malaria increase

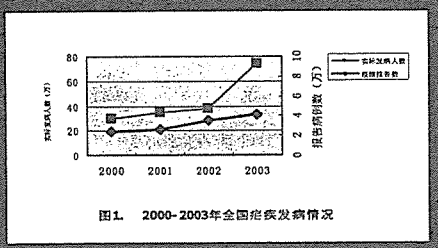


图1. 2000-2003年全国疟疾发病情况

Some features related to malaria transmission in China

Region	Transmission period	Species of Plasmodium	Vectors
South of 25°NL	9-12 months	*P. vivax*	*An. minimus*, An.dirus***
	6-8 months	*P. falciparum**	*An. L.candidiensis*
		P. malariae	*An. sinensis*
25-33°NL	6-8 months	*P. vivax**	*An. sinensis**
		P. falciparum	*An. anthropophagus***
		P. malariae	*An. L. candidiensis*
North of 33°NL	3-6 months	*P. vivax*	*An. sinensis* An. Messeae*
Northwest of 33°NL	Non-endemic area		

* major species ** major species in some localities

Malaria surveillance program

Malaria surveillance program is one of the important parts of "National Program on Malaria Control in 1991-1995"and National Program on Malaria Control 1996- 2000" National Program on Malaria Control 2001-2015"in China.

Organs for malaria control in China

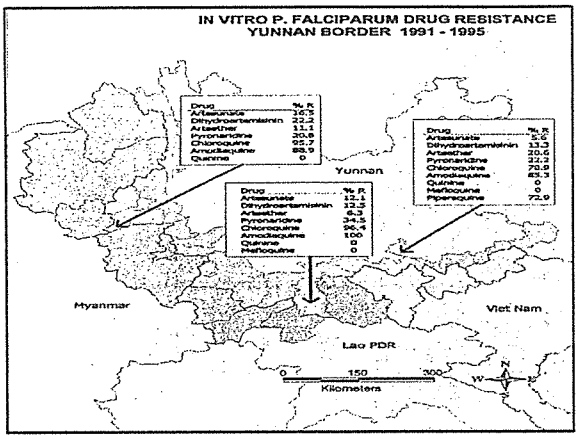
Dept. of Disease Control ⟷ Advisory Committee on Malaria
Ministry of Health ⟷ Institute of Parasitic Diseases, China CDC
↓ ↓
Division of Disease Control ..... Provincial CDC or Provincial IPD
Provincial Bureau of Health
↓ ↓
Health & Epidemic Prevention .... County CDC or Health Station
County Bureau of Health
↓
Health & Epidemic Prevention .....
Group, Township Health Center
↓
Primary Health Care
in Administrative Village

Strengthen vivax malaria surveillance

- To know where malaria is endemic and how serious it is;
- To identify high-risk areas;
- To monitor progress towards the interruption of malaria transmission;
- To predict malaria trend, outbreak, incidence etc.

Vivax malaria surveillance covers

- Case detection
- Focus intervention
- Management on mobile population
- Drug resistance
- Vector monitoring



Main parameters used in vivax malaria surveillance

Annual parasite incidence (API);
- Annual blood examination rate (ABER)
- Annual vivax incidence (AVI)
- Slide positivity rate (SPR)

Main indicator for vector surveillance

feeding and resting behaviour
human biting rate
human blood index
vectorial capacity

Monitoring

※ Enviroment
rainfall, in some cases local surface waters depend on rainfall- or snowfall- upstream;
temperature;
humidity;
surface water.

Medium- or long-term risk

Long term changes, e.g. in housing, relative numbers and accessibility of domestic animals, management of surface waters may eventually prevent malaria epidemics, but are unlikely to be planned for that purpose.
Monitoring the risk ; build up the capacity to investigate suspected epidemics and to plan and implement emergency measures.

Strengthening case report system

Village doctors/private doctors/clinics
Township hospital/other hospitals
County CDC
Prefecture/city CDC
Provincial CDC
China CDC

Control of malaria in migrant population

Malaria intervention work should be appointed to special personnel in relevant units situated at construction site or economic developing region in endemic areas. Under the guidance of local anti-epidemic station or department, elucidated information about the extent of prevalence and the major vector should be achieved after on-site survey.

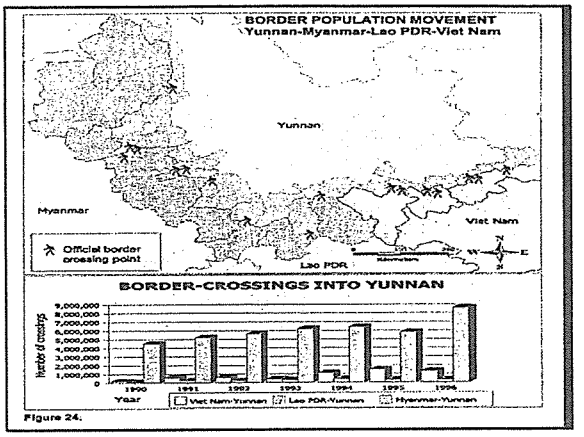


Figure 24.

Malaria early warning system

Three main group of indictors to predict the timing and severity of a malaria epidemic:

Vulnerability indicators

Transmission risk indicators

Early detection indicators from health facility malaria morbidity data

Malaria early detection

Surveillance data

Use of sentinel sites

Use of laboratory-diagnosed malaria data

Temporal analytical techniques

Analysis of time series data

Time-series cross correlation and linear regression

Conclusion

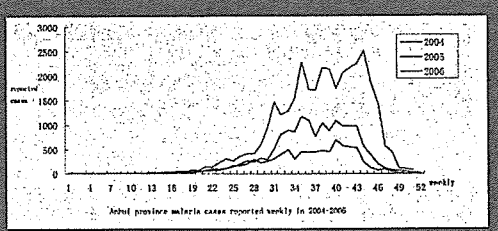
Based on the formula of basic reproductive rate

Study on transmission density-threshold of *An. sinensis* for malaria in the Northern Anhui Province

Results The human blood index for *An. sinensis* was 0.1771 and the mean multiparous ratio was 0.51. In study spot, the adjusted human-biting rate for *An. sinensis* was 11.1877 and the critical human-biting rate was 7.6340, the adjusted human-biting rate was 1.47 times of its critical human-biting rate.

Conclusion A reduction of the adjusted human-biting rate of *An. Sinensis* by 47% is needed for interrupting malaria transmission by this vector in the study area.

Analysis of data during transmission season



Anhui province malaria cases reported weekly in 2004-2006

An. sinensis is still a very important vector transmitting *vivax* malaria in central provinces because of its extensive distribution and big population. In recent years according to annual reporting system, most of malaria cases are found in areas where *An. sinensis* is only vector.

Prospective

Malaria control and surveillance will be strengthened, and drug policy will be further developed in China

Further decrease the incidence in most of endemic areas in central part of China

For malaria control in Yunnan and other border provinces, it is necessary to cooperation with WHO Roll Back Malaria, other international organization and the neigh bordering countries