

(English Translation of)

Ma, S.-F. 1981. Studies on the Anopheles (A.) sinensis group of mosquitoes in China, including four new sibling species. Sinozoologia (1), pp. 59-70.

As early as 1828, Wiedemann collected adults of Anopheles (A.) sinensis in Guangdong Province, China, but because these specimens were morphologically similar to Anopheles (A.) hyrcanus, they were described as Anopheles (A.) hyrcanus var. sinensis Wiedemann. This name was used for many years. However, recent taxonomic research has shown that specimens conventionally classified as A. (A.) hyrcanus variety sinensis are actually members of a complex species group.

The A. sinensis group ranges from Europe through Africa and Asia. In China, the group is widespread and includes several important vectors of malaria and of Malayan and Bancroftian filariasis.

Outside China, research on the A. sinensis group has been conducted by, among others, Reid (1953, 1963), and Harrison et al. (1972, 1973) in Southeast Asia; Otsuru (1949), Miyazaki (1951), Otsuru & Ohmori (1960), and Kanda & Oguma (1976, 1977) in Japan; and Gutsevich (1976) and Maslov (1946) in Russia.

In China, Y.-T. Yao et al., Walch, and Walch-Sorgdrager (1934, 1935), among others, noted differences in populations of A. sinensis in the Nanking area. These studies were not further pursued. After 1948, Feng Lan-zhou and Ma Su-fang (1956, 1958) were the first to hypothesize that the varieties of A. sinensis might play different roles in the transmission of malaria or

Malayan filariasis in China; their observations were followed by those of Liu Wei-dei (1959 [sic]), Ho Chi et al. (1962), Zhang Ben-hua et al. (1964), Liu En-fu & Chen Jian-xing (1959), Shu Guang-hai (1962), Feng Lu-bo (1964), and Ma Su-fang (1964-1966), among many others. During this period, Ma Su-fang recorded differences in egg morphology as well as differences in the morphology of each instar of A. sinensis, all of which led to the description of five varieties of this species. The various egg float patterns were shown to be conspicuously different from those of typical A. sinensis; however, the taxonomic significance of such observations remained unclear. Finally, in 1975 Xu Jin-jiang et al. issued their report "Studies on the Anopheles hyrcanus group of mosquitoes in China," which answered some of our questions. Yet, there remain many more problems that call for further research.

Between 1953 and 1960 and again from 1961 to 1977, Feng Lan-zhou and Ma Su-fang made meticulous studies of the A. sinensis group in China. More than 10,000 specimens were collected and identified from over 20 provinces. Life histories, geographical distribution, and disease relationships were analyzed. Specimens were collected and studied in north, northeast, central, south, and northwest China; in fact, in all regions except Xizang, Yunnan, and Xinjiang. Moreover, specimens were observed, collected and studied on a year-round basis in Beijing, Hangzhou, and Guangzhou. During the latter phase of this study, specimens were re-examined from the provinces and regions of Beijing, Hebei, Liaoning, Jilin, Heilongjiang,

Xinjiang, Ningxia, Gansu, Xizang, Shandong, Henan, Hubei, Hunan, Guangdong (including 6 counties on Hainan), Guangxi, Sichuan, Guizhou, Yunnan, Jiangxi, Jiangsu, Zhejiang, Shanghai, and Fujian.

In order to observe micromorphological features of adults and eggs, we subjected the several varieties of A. sinensis to scanning electron microscopy, which provided important additional characters to segregate these forms.

Besides morphology, we analyzed the effects of the environment on A. sinensis, including different habits produced by ecological isolation (bioenvironmental isolation, seasonal isolation, etc.), and the connection between ecological variables and human or animal disease; such factors have had a major impact on the phylogenetics of this group.

Pronounced differences in the habits of various mosquitoes are an expression of discontinuity between species (though species differences are expressed in many other ways as well). In the A. sinensis group, breeding habits provide diagnostic species characters. Briefly, differences in water quality favor different species; thus, the mosquito fauna of clean water differs from that of polluted water. Before the arrival of man and his domestic animals, polluted water was virtually nonexistent; with the development of human societies, concentrations of human and domestic animal waste led to the pollution of large bodies of water. The number of A. sinensis surviving in clean water gradually decreased, while the number surviving in polluted water steadily increased. In time, the

wild type gave rise to a semidomestic form that expanded its range to become the predominant species. By contrast, species restricted to clean water (e.g., A. anthropophagus, A. dazhais, A. kweiyangensis, etc.) have suffered sharp reductions. Differences of this nature are species-specific.

When addressing the phylogenetics of a close-knit species group, it is usually impossible to cite direct observations of reproductive isolation; rather, arguments for such isolation are usually based on indirect evidence. One form of evidence is sympatry. For example, A. sinensis and A. anthropophagus are sympatric species, as are A. sinensis and A. xiaokuanus; despite years of observation, no one has recorded morphological transition forms between these taxa. The same can be said for A. sinensis and other species that coexist over the same area. We attribute the absence of intermediates between sympatric species to reproductive isolation.

Furthermore, close examination of sibling species has shown that the number and shape of the aedeagal leaflets vary between species (of course, there is some intraspecific variation as well); such differences may interfere with mating or impede reproduction.

Outside China, several researchers have conducted experiments to test reproductive isolation, notably Y. Nagashima et al. (1976, 1978), T. Kanda et al. (1976, 1977), and Kanda et al. (1976, 1977) in Japan. These workers attempted to cross Japanese A. sinensis and A. lesteri; they also tried to mate Indonesian A. sinensis, A. nigerrimus and A. crawfordi with Iranian A.

pseudopictus. In most cases, eggs were nonviable or larvae died shortly after eclosion; the few specimens that completed their development died very soon. During these experiments, the frequency with which males moved their claspers was observed to vary between species. Clearly, such results are evidence of reproductive isolation.

On the basis of ecological as well as morphological characters, we believe that A. lesteri anthropophagus of Xu & Feng (1975) is a distinct species rather than a subspecies. Our collections from Guangdong (including Hainan), Guangxi, Fujian, Zhejiang, and the Shanghai coastal area have failed to yield a single specimen of A. lesteri. Though A. lesteri has been reported from Hong Kong, the determination was based solely on adult morphology and without regard to habitat, breeding behavior, disease relationships, or the A. lesteri/anthropophagus question. A. lesteri may well occur in Hong Kong, but A. anthropophagus is found in mainland China (where it has been called the small, narrow deck form of Anopheles sinensis), and it is definitely distinct from A. lesteri.

Past research combines with our current understanding to produce the following picture: in China the A. sinensis group comprises 16 closely related species. These account for about half of the 32 Chinese members of the subgenus Anopheles. We have recorded 4 new species, 2 new records, and one species correction. With further research along our borders and coast, we expect that the number of species will increase, particularly in the Palearctic.

The principal morphological characters of adult females belonging to the A. sinensis group are: antennae with 4 narrow white rings; labium with a patch of scales to either side; metathoracic tarsi with white rings, 4th and 5th tarsomeres rarely pure white; 7th abdominal sternite with a patch of scales; and base of 5th longitudinal vein (Cu) with a clear dark spot.

Key to the 16 Species of the Anopheles sinensis Group

1. Base of costa with 1-2 pale spots.....2
 Base of costa uniformly colored or with scattered pale
 scales.....5
2. Vein V_6 [anal vein] with 3 dark spots.....3
 Vein V_6 [anal vein] with 2 dark spots.....4
3. Base of costa with 2 small pale spots (Distribution: Jilin,
 Liaoning, Zhejiang; also Japan, South Korea, etc.).....
 Anopheles (A.) sineroides
 Base of costa with 1 small pale spot (Distribution: Henan,
 Anhui, Hubei, Zhejiang, Jiangxi, Fujian, Guizhou, Yunnan,
 Sichuan, etc.).....Anopheles (A.) kweiyangensis

4. Base of costa with 1 small pale spot and scattered pale scales. Humeral vein with 1 row of dark scales. Aedeagus with few leaflets, 3 to either side in lateral view. Shape of microtrichia on female wing various (plate IV: 3) (Distribution: Fujian, Guangxi, Yunnan, Guizhou; also Thailand, India, Malaysia, Indonesia, Vietnam, Cambodia, etc.).....Anopheles (A.) nitidus¹
- Base of costa not as above. Humeral vein bare. Aedeagus with many leaflets, 6 to either side in lateral view (Distribution: Yunnan; also Thailand, Cambodia, India, Malaysia, Vietnam, etc.).....Anopheles (A.) crawfordi²
5. Stem of radius pure white.....6
Not as above.....8
6. White ring on 4th segment of female metathoracic tarsus exceptionally broad and pure white; male terminalia with dense white scales dorsolaterally and with 2 large spines laterally: one stout and short, arising from a process, the second slender and long, not arising from a process. 9th abdominal tergite broader than in A. hyrcanus. Aedeagus with 4-5 leaflets, first leaflet with 3 large apical teeth and 3 basal teeth. Second leaflet with 2 smaller apical teeth and 2 basal teeth. Third through 5th leaflets without apical teeth but each with 1 basal tooth. Claspers small, with 3 long tufts (Distribution: Xinjiang; also Italy, etc.).....
.....Anopheles (A.) pseudopictus

White ring on 4th segment of female metathoracic tarsus
inconspicuous, not exceeding 1/2 length of this segment.
Male terminalia with few white scales dorsolaterally.....7

7. Base of costa without spots. Deck about 15% of egg width.
Metatarsus with narrow white ring, 1st through 4th tarsomeres
each with a narrow, apical white ring about as long as width
of leg (Distribution: northeast China, Hebei, Shandong; also
Japan).....Anopheles (A.) yatsushiroensis

Scales at base of costa not uniformly colored. Deck about
20.4% of egg width. Metatarsus with broader white ring as
well as basal and apical white rings; length of white rings
of 1st through 3rd tarsomeres about 3 times width of leg
(Distribution: Beijiang, Hangzhou, and Mudanjiang in
Heilongjiang).....Anopheles (A.) xiaokuanus

8. Stem of radius mostly dark or with a mixture of dark and pale
scales.....9

Stem of radius mostly pale.....15

9. Stem of radius mostly dark or with very few pale scales...10

Stem of radius a mixture of dark and pale scales.....12

10. Third through 5th tarsomeres of female metatarsus each with a remarkably broad white ring (the most prominent in this group of mosquitoes). Aedeagus with about 2 pairs of leaflets, one of which bears lateral teeth that are more numerous than in A. nigerrimus (Distribution: Yunnan; also Indonesia, Malaysia, Cambodia, India, Vietnam, etc.).....
Anopheles (A.) argyropus¹
 White rings of female metatarsus much narrower than above.11
11. Base of vein V₅ [cubital^{US} vein] usually with several dark scales followed posteriorly by a conspicuous pale spot and, in turn, a large dark spot, then pale scales to the fork of this vein. Egg type broad. Aedeagus with 5 pairs of long and slender leaflets, apex of 1st leaflet knifelike, with 1 large apical tooth and 2 small basal teeth; 5th leaflet with 3 small basal teeth but no apical teeth; other leaflets simple (figure 2: 5) (Distribution: Sichuan).....
Anopheles (A.) changfus
 Base of vein V₅ [cubital^{US} vein] with dark scales followed posteriorly by a small pale spot and, in turn, a large dark spot, then pale scales to the fork of this vein. Egg type narrow. Aedeagus with 2 pairs of leaflets and far fewer lateral teeth than in A. argyropus (figure 3: 5)
 (Distribution: Fujian, Guangxi, Guizhou, Yunnan, Jiangxi, Sichuan, etc.; also India, Sri Lanka, Malaysia, Philippines, Cambodia, Thailand, Vietnam, and Indonesia [Java, Kalimantan, Sulawesi, etc.].....Anopheles (A.) nigerrimus

12. Humeral vein with few scales; coxae with patches of white scales; in female, 2nd through 7th abdominal sternites with conspicuous triangular spots laterally; wings with microtrichia arranged in a few rows, the microtrichia themselves relatively slender and elongate (plate III: 4; plate IV: 1) (Distribution: in China, ubiquitous; also Thailand, Burma, Cambodia, India, Indonesia, Malaysia, Japan, Singapore, Vietnam, Korea, USSR, etc.).....
Anopheles (A.) sinensis
 Humeral vein without scales.....13
13. Coxae with patches of white scales. Metatibia with broad white rings basally and apically. First through 4th tarsomeres of metatarsus each with a broad, white apical ring and a narrow, white basal ring. Vein V_5 [cubital vein] basally covered with snow-white scales, apically with 1 large dark spot. Frons with distinct, long white tufts extending toward eyes; occiput with many erect white scales; anterior margin of mesonotum with many long, slender, hairlike scales. Scutellum pale, with long white or light brown setae. Aedeagus with 4-5 pairs of leaflets, most with lateral teeth (figure 3: 3, 4). Wing microtrichia relatively stout, their apices blunt (plate III: 7, 8). Body with a distinctly black and white appearance (Distribution: Heihe in Heilongjiang)..
Anopheles (A.) heiheensis

Coxae without patches of white scales. In female, 2nd through 7th abdominal sternites without conspicuous triangular spots.....14

14. Female wings with a few scattered microtrichia, their bases swollen and rounded, the microtrichia themselves slender, sharp, and broadly curved (plate III: 1, 2; plate IV: 4). Aedeagus with 5 pairs of leaflets (figure 2: 11, 12)

(Distribution: provinces south of Changjiang [Yangtze River])

.....Anopheles (A.) anthropophagus¹

Female wings with numerous, densely arranged microtrichia, their bases slightly curved, their apices blunt (plate III: 3; plate IV: 5). Aedeagus with few leaflets, about 3 pairs (figure 2: 7) (Distribution: known only from Sichuan).....

.....Anopheles (A.) dazhaius

15. Female coxae without patches of pale scales; pro- and metatarsus with broader white rings. Apex of vein V_1 [radius-1] pale; apex of vein $V_{5.2}$ [cubitus anterior] without pale spot in fringe; dark spot at base of vein V_6 [anal vein] longer. Ventrolateral triangular spots obscure. Egg small, tubercular, its surface ornamented with a floral pattern (plate II: 7, 8) (Distribution: Hainan, Fujian, Ghizhou, Yunnan; also Sri Lanka, India, Burma, Thailand, Malaysia, Philippines, and Indonesia [Java, Kalimantan, Sulawesi]).....Anopheles (A.) peditaeniatus

Female coxae with patches of pale scales. Apex of vein V_1 [radius-1] dark, vein $V_{5.2}$ [cubitus anterior] usually with pale spot in fringe; base of vein V_6 [anal vein] with short pale spot. Ventrolateral triangular spots distinct. Mesonotum silver-gray, longitudinal patterning unlike species above (Distribution: Xijian; also USSR, Mediterranean countries, Iran, etc.).....
Anopheles (A.) hyrcanus²

New Species

1. Anopheles (A.) changfus, new species

Widespread in Sichuan. In 1966, the author reported this species as the "long float, wide-deck form of Anopheles sinensis" and provided detailed descriptions of all instars.

This is a hardy species capable of breeding in clean or polluted water and in a variety of habitats (plains, hills, mountains, etc.). Yet, its apparent absence outside Sichuan calls for further investigation.

Females prefer the blood of domestic animals and are most often found in barns; however, they occasionally enter homes and feed on man.

This species is very similar to both A. sinensis and A. dazhais; for distinguishing characters see key above.

Distribution: Sichuan. Holotype female, allotype male, and all paratypes--50 females, 50 males, 10 pupae, 10 larvae, and 100 eggs--collected July-September 1964 on Emeishan Mountain,

Sichuan, by Ma Su-fang. All specimens have been deposited in the Institute of Zoology, Academia Sinica.

2. Anopheles (A.) dazharius, new species

In 1964 and again in 1966, the author reported this species as the "large, narrow-deck form of Anopheles sinensis" and provided detailed descriptions of all instars.

Adult: Base of costa dark, with no admixture of pale scales. Humeral crossvein without scales. Trunk of radial vein chiefly with pale scales. Fringe without or with only a few minute pale spots. Shape of microtrichia of wing membrane unlike that of related species (plate III: 3; IV: 5). Aedeagus with 3-4 pairs of leaflets, 1st leaflet with 1 basal and 1 apical tooth; 2nd-3rd leaflets with 1-2 basal teeth but no apical teeth (figure 2: 7).

Egg: Outer row of deck tubercles larger than those closest to midline. Number, shape, and distance between lobed tubercles all variable (plate I: 7, 8). Chorionic sculpturing pentagonal (plate II: 3).

Additional characters have been reported elsewhere and will not be repeated here.

Distribution: This is the narrow egg form of Anopheles sinensis that is widespread in Sichuan but uncommon everywhere else--including the neighboring province of Guizhou. The author's 1965 explorations failed to uncover additional specimens, and this matter should be further investigated. Holotype female, allotype male, and all paratypes--10 females, 10 males, 10 pupae, 10 larvae and 100 eggs--collected July 1962;

also eggs, larvae, pupae and adults collected July 1964 by Ma Su-fang. All specimens have been deposited in the Institute of Zoology, Academia Sinica.

In Sichuan, this species is sympatric with A. changfus, A. anthropophagus and A. kweiyangensis but breeds in a different habitat; where it coexists with A. anthropophagus, the two populations differ greatly in size, there being very few A. anthropophagus, many A. dazhais, but no intermediate forms.

This species is probably of considerable medical importance, since females are known to prefer human blood. Though we have not observed the malarial parasite per se, we note that in malarious districts large numbers of A. dazhais may be collected from from mosquito netting, especially the bed nets of patients suffering from this disease. By contrast, in areas with little or no malaria, A. dazhais is less often collected. We presume that A. dazhais is the vector of malaria in Sichuan and, as such, should receive priority consideration for further research.

3. Anopheles (A.) heiheensis, new species

Adult: Body notably large, with conspicuous black and white scales. Antennal pedicel and basal segments 1-4 covered with flat white scales. Maxillary palpi stout, uniformly dark, without pale scales but with 4 narrow white rings; palpal apices pale, with long white setae. Vertex and occiput with numerous straight, forked scales; frons with many salient pale tufts and slender scales above interocular area.

Mesonotum yellowish brown, ground texture frosted but with 3 longitudinal lines. Notum with long golden tufts and with 1 patch of slender white scales at center of anterior margin. Four setae at spiracular opening, 14 setae on mesopostpleuron; about 15 setae on ventrolateral plate.

Wing with conspicuous dark and pale scales. Base of costa with several pale scales (about 4), otherwise uniformly dark brown throughout. Subcostal pale spot divided equally between apex of subcosta and 1st longitudinal vein, ^[6] thus differing from pattern of A. sinensis. Apical pale spot covering longitudinal vein I-3 but generally smaller than in A. sinensis, though given to variation. Subcosta uniformly dark except in area of subcostal pale spot. Base of 3rd longitudinal vein, ^[R4+5] with 1 small dark spot followed by a pale spot twice its size, then dark scales bisected by a single line of pale scales. Base of 5th longitudinal vein, ^[medicubital crossvein] with 1 large pale spot followed by 1 large dark spot, the two spots about equal in size, then uniformly pale scales. Apex of longitudinal vein 5.2 with 1 small dark spot, otherwise pale. Longitudinal vein 6, ^[oval vein] its center and apex each marked by 1 large dark spot. Longitudinal vein 5.2, ^[costal posterior] without spot in fringe. Humeral crossvein without scales. Base of radius chiefly with pale scales, but apex with yellowish white scales over just less than half its area.

Coxae with clusters of pale scales. Femora and trochanters basally with large aggregations of white scales. First and 2nd prothoracic tarsomeres basally with broad white rings about twice width of leg, 3rd tarsomere with narrow white basal ring about

equal to width of leg; 4th and 5th tarsomeres black. Pro- and mesothoracic tarsi similar. First through 4th metathoracic tarsomeres basally with white rings about twice width of leg, but 1st through 3rd tarsomeres additionally with apical white rings about equal to width of leg; in combination, these basal and apical rings produce broad white bands. Fifth metathoracic tarsomere black.

Male terminalia densely covered with scales. Aedeagus with 4-5 pairs of leaflets. First leaflet with lateral teeth for at least half its length and with at most 1 apical tooth. Second leaflet either with lateral teeth similar to those of 1st leaflet and without an apical tooth or with several basal teeth (figures 2: 1 and 3: 3, 4).

Distribution: Heilongjiang Province, Heihe area. The author's collections are from Yueyagou, Aihui County, Heihe. Above description based on 2 males and 1 female. Holotype female, allotype male, and paratype male all deposited in the Institute of Zoology, Academia Sinica.

Larvae were found in rice fields, irrigation canals, etc. From these larvae, 3 adults were reared. Adult habits remain unknown.

This is a Palearctic species. Formerly, A. heiheensis was confused with A. sinensis and A. xiaokuanus, all three having been lumped together under A. sinensis. However, much careful research has demonstrated pronounced differences between these taxa, as illustrated by the condition of the female maxillary palpi, which may or may not bear white scales; thus, in A.

xiaokuanus and A. sinensis the internal lateral surfaces of the maxillary palpi are clothed in white scales, while in A. heiheensis such white scales are absent. Again, in A. heiheensis the head is covered with many white scales, but in the other two species these scales are less numerous. In addition, the aedeagal leaflets differ. Our collections were made north of 48° latitude along the banks of the Heilongjiang River; this is a cold and humid area that apparently differs ecologically from points inland. Because of its distinctive morphological features and the fact that no intermediate forms have been discovered to date, we name the A. sinensis-group Anopheles of this area A. heiheensis. Much additional research is needed on the Palearctic component of the A. sinensis group.

4. Anopheles (A.) xiaokuanus, new species

In papers published between 1964 and 1965, this writer described in detail the morphology of each instar of what was then called the "small wide-deck form of Anopheles sinensis." This form is hereby elevated to species and additional characters are presented.

Adult: Stem of radius entirely pale. Humeral crossvein mostly without scales. Apex of vein V_{5.2}^[cubitus anterior] with or without pale spot in fringe (pale spot present in about half the specimens examined). Distribution, shape, size, and density of wing microtrichia all unlike those of related species (plate III: 6; IV: 2). Metatarsal white rings distinctly unlike those of A. yatsushiroensis (see Table 1). When assessing these characters,

allowance should be made for their range of variation.

Male terminalia with more white scales and setae dorsolaterally than in typical A. sinensis; laterally with more brown scales and setae. Aedeagus with 4-5 pairs of leaflets. First leaflet large, either with about 6 small teeth arranged in a lateral row from base to apex or with 1 basal tooth and 3 apical teeth; 2nd leaflet longer and more slender than 1st, with 2-3 basal teeth but no apical teeth; 3rd through 5th leaflets very small and slender, with 2-3 basal teeth but no apical teeth (figure 2: 2, 3, 4).

Egg: Coarsely textured, the ends more rounded and blunt and not curved upwards as in other species. Deck wide, with occasional variation, and ornamented with large, dark deck tubercles (figure 3: 2-c) that together with the shape of the frill are unlike those of other species, as can be seen under SEM (plate I: 3). Deck about 20.4% of egg width. Distance between float and deck greater at center of egg, less at ends. Ribs 18-37 in number, averaging 27.2 and usually 27-28. Lobed tubercles 4-9 in number, usually about 6, petallike in outline, the number, shape, size and degree of notching between "petals" all species-specific (plate I: 3). Sculpturing of egg chorion distinctive and an important character in species of the A. sinensis group (plate II: 2, 6).

Distribution: Most collections have been made in Heilongjiang Province, especially in the vicinity of the Mudanjiang River. However, this species is also known from Beijing, and a very few specimens have been taken in Hangzhou. Holotype female, allotype

male, and all paratypes--10 females, 10 males, 10 larvae, 10 pupae, and 50 eggs--collected August 1964 along the Mudanjiang River by Ma Su-fang (all specimens have been deposited in the Institute of Zoology, Academia Sinica). Larvae are most abundant in north and northeast China above 30° latitude, where they inhabit cold, clear water, usually with a pebbled bottom and well shaded by vegetation, e.g., rice fields, irrigation ditches, the edges of small streams, etc. Adults show a strong preference for human blood but will also feed on domestic animals.

A. xiaokuanus is quite similar to A. yatsushiroensis, but see Table 1.

It has been suggested that A. xiaokuanus is conspecific with A. yatsushiroensis, but careful comparison of these taxa reveals many differences (see Table 1). Since A. yatsushiroensis also occurs in China, species determinations should be made with care.

Our observations have led us to conclude that variation is greatest in the following characters: width of the white rings on the maxillary palpi, size and/or presence of wing spots, and width of the white rings on the metatarsi.

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Footnotes

Page 59: Received 3 May 1979.

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Page 61: 1) Formerly A. indiensis. Harrison (1973) determined that the type had been lost and, noting that the original description was vague, declared this a nomen dubium. He later examined related material from many museums as well as research reports of earlier investigators in India and Southeast Asia, but he was unable to verify the existence of this taxon. Harrison then declared A. indiensis a nomen nudum. Chinese workers still mistakenly use A. indiensis, which should be corrected to A. nitidus. The author has examined Chinese specimens of so-called A. indiensis; these have been collected only in Guangxi, Yunnan, Guizhou and surrounding areas, and they are all definitely A. nitidus. I therefore agree with Harrison.

Page 61: 2) New record.

Page 62: 1) New record.

Page 65: 1) Formerly referred to by this writer as the very small, narrow-deck form of Anopheles sinensis. Xu & Feng (1975) named this taxon A. lesteri anthropophagus, but its morphology, ecology, distribution, and role in disease transmission, among other factors, convince us that this is a separate species.

Page 65: 2) The original description of Pallas (1771) was extremely vague but remains in force, with the result that identification of this species is difficult. Huang Chong-an (1960) and Xu & Feng (1975) reported A. hyrcanus from Xijiang. Over the past two years, we have collected mosquitoes in various parts of Xijiang, but we have yet to find this species and we therefore believe that if it does occur in Xijiang, it must be quite rare. Clearly, we should further explore Xijiang as well as Qinghai, Xizang, and neighboring areas. Though poorly documented, A. hyrcanus is included in this account because it is a member of the Anopheles sinensis group, which is of paramount importance throughout China.

Legend for Figures

Figure 1. Male terminalia of Anopheles pseudopictus, etc.

- 1-4. A. pseudopictus: Male terminalia, morphology and variation in aedeagal leaflets [collected in Xinjiang Province, assigned no. 1 = Xin 1109; 2 = Xin 7; 3 = Xin 1];
5. A. pseudopictus: Male terminalia, clasper with 3 long tufts [Xinjiang, assigned no. Xin 7];
6. Same as above: Shape of 9th tergum [assigned no. Xin 7];
7. A. hyrcanus: Male terminalia, aedeagal leaflets [after Xu].

Figure 2. Male terminalia of Anopheles xiaokuanus, etc.

1. A. heiheensis: Aedeagal leaflets (assigned no. 9);
- 2-4. A. xiaokuanus: Aedeagal leaflets (assigned no. 2, 4 = 13, 3 = 14);
5. A. changfus: Aedeagal leaflets (assigned no. 18);
6. A. dazhais: Shape of 9th tergum of male (assigned no. 11);
7. A. dazhais: Aedeagal leaflets (assigned no. 16);
8. A. sinensis: Aedeagal leaflets (assigned no. 21);
9. A. xiaokuanus: Shape of 9th tergum of male (assigned no. 13);
10. A. kweiyangensis: Aedeagal leaflets (assigned no. 12);
11. A. anthropophagus: Aedeagal leaflets (assigned no. 15);
12. A. anthropophagus: Shape of 9th tergum of male (assigned no. 17).

Figure 3. Eggs of Anopheles sinensis group and male terminalia of A. heiheensis.

1. Egg characters of the A. sinensis group;
2. Same as above, enlargement of anterior end:
 - a. lobed tubercles or bosses;
 - b. frill;
 - c. deck tubercles;
 - d. float;
 - e. deck.
3. A. heiheensis: Aedeagal leaflets (assigned no. 33),
4. A. heiheensis: Male terminalia, morphology of clasper (assigned no. 33),
5. A. nigerrimus: Aedeagal leaflets (assigned no. 26).

Table 1

<u>A. xiaokuanus</u>	<u>A. yatsushiroensis</u>
Female: 1) Maxillary palpus with 4 broad white rings	1) Only 2nd white ring of maxillary palpus is broad
2) Dark and pale scales of wing distinct	2) Contrast between dark and pale scales not conspicuous
3) Scales at base of costa not uniformly colored	3) Scales at base of costa without spots
4) Scales at base of vein V_1 [radius-1] chiefly dark, with only a slight admixture of pale scales, as in specimens from the Mudanjiang and Beijing areas	4) Half of scales at base of vein V_1 [radius-1] almost pure white, with only a small admixture of dark scales
5) Basal and apical white rings of metatarsus conspicuously broad	5) Metatarsomeres 1-4 with only narrow apical white rings
Pupa: 6) Seta 2 of abdominal segment III with 15 branches; seta 2 of abdominal segment IV with 13-19 branches	6) Seta 2 of abdominal segment III with 7-22 branches; seta 2 of abdominal segment IV with 9-23 branches

- Egg: 7) Deck about 20.4% of egg width, egg length 524.6-799.8u, mean 631.2u; mean egg width 205.5u; mean float length 398.2u; lobed tubercles 4-9 in number
- Habits: 8) Females prefer human blood but will also feed on domestic animals; more common in homes than in cattle barns
- 9) In the vicinity of Beijing, adults are numerous from mid-August to mid-September but are especially common from late August to early September
- 7) Deck about 15% of egg width, mean egg length 588.2u; mean egg width 194.8u; mean float length 351.1u; lobed tubercles 5-6 in number
- 8) Adults have most often been collected along barren seashores or at sea
- 9) In Japan, most numerous in July and October

10) Larvae prefer cool, clean water that is well shaded by vegetation. Found chiefly in the mountains and uplands of north China where it coexists with A. sinensis

10) Larvae are usually found in rice fields, irrigation ditches, or near the banks of small creeks; often occurs in association with A. sinensis, rarely with A. lesteri