

## CLASSIC PAPER

THE TIGER MOSQUITO IN SHANGHAI<sup>1</sup>

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The mosquito which probably annoys us most in Shanghai is the little black one with silvery white stripes popularly, or, rather, unpopularly, called the tiger mosquito. The members of this species have been unusually troublesome pests during the past summer and autumn, and most of us have had painful reminders of their voracity. This particular mosquito does not await the evening hours to steal her repasts, but makes for our uneasiness during those forty winks which we may allow ourselves after luncheon. Most of our summer mosquitoes are more conventional, and regulate their meal hours to the hours of darkness, when they can make good their escape more readily. Not so the tiger mosquito, which has the audacity to attack us in broad daylight. She is bold and daring and it takes all our prowess with the swatter to score against the elusive little devil. Here self confidence is supreme and tactical ability in guerilla warfare amazing.

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*The China Journal* was published by the China Society of Science and Arts in Shanghai from 1923 until 1941 when the last of 35 volumes was printed. From the contents which included articles in history, archeology, economics, literature and natural history and the advertisements, this magazine was evidently directed towards the resident foreign community. Unfortunately, the publication had only limited circulation abroad and only one or two complete sets of volumes are deposited in libraries.

Although published more than 50 years ago, the paper by Robertson and Hu still provides some interesting information about the bionomics of *Aedes albopictus*. The authors were well aware of the disease potential of this species and even speculate upon the future role of aircraft in the dispersal of vector species. The absence of *Aedes aegypti* from their discussion of the urban mosquitoes of Shanghai would tend to indicate that *Ae. aegypti* was either absent from the city or of very minor consequence. It is also quite apparent that *Ae. albopictus* overwintered in Shanghai due to the wide distribution during the summer months. -- R. A. Ward, *Editor*.

The tiger mosquito, known scientifically as *Aedes albopictus* (Skuse), as the name indicates, is a black creature with distinct white markings. There is a conspicuous silvery white line along the middle of the thorax, in line with another at the back of the head. Examine at close range the next tiger mosquito which you may not have smashed to an unrecognizable pulp, and you will see the distinctive scheme of decoration. Without the help of a hand lens you can readily see the legs elegantly banded with white rings. Look at the sides of this brilliantly marked creature and observe the bright spots on the thoracic wall and the silver-banded abdomen.

The male can be distinguished by his more bushy antennae. Note that his palps, those along side of the proboscis, are longer than those of the female. As he is not ferocious like his better half, his mouth parts are rather undeveloped, not being fitted for puncturing the skin. The male has shorter and less developed wings than the female. He is a harmless creature and quite devoid of bloodthirsty inclinations. His diet being vegetarian, he prefers sweet nectar and fruit juice. He need not be so quick and agile in his flight, and is a frail creature compared with the robust female. The latter is equipped for a much more ambitious role in the scheme of things. She has to nourish a fat brood of eggs, and has to adventure on dangerous expeditions in search of her victims for meals of blood.

Should the reader find tiger mosquitoes as unfriendly companions in his room, he may rest assured that the breeding places are not far away, very probably in his own garden or in that of his immediate neighbour. The tiger mosquito has enjoyed a long acquaintance with man. This is indicated by her domesticity and adaptability to our ways. Having acquired a taste for our blood, she has developed innumerable tricks the better to steal her meals off us and "get away with it." For instance she does not herald her approach by buzzing and singing as some other less wary mosquitoes are apt to do. She does not intend to give herself away. She believes that silence is the better part of discretion when she is out for blood.

Apparently full of a knowledge of the ways of man, the tiger mosquito does not plan her attacks indiscriminately. She appears to know

where our weak spots are, as well as where it is dangerous to alight. From the experience of many a bite during these summer months, we are inclined to conclude that the tiger mosquito generally lands on those portions of our anatomy where we will be least able to reply so immediately with a slam. In most instances she prefers to settle on our legs. By the time we bend over in our attempts to squash her she has been sufficiently warned by our movements as to what is coming, and off she goes, much to our chagrin. She seems to know that the lower portion of the leg is the safer, as there must be more bending to do if her presence is unduly noticed. Even when we are wearing shorts, we are likely to be more bitten about the ankle than about the knees. The bare skin about the knees is scarcely enough to tempt her. She would rather play safe and insert her needlelike blood-sucking apparatus through the crevices of the stockings further down. The back of the neck is another choice spot for her attention. Other spots that she is likely to land on are those where there would be considerable commotion on our part if we should make an attempt to get at the little beast, such as the back of the elbow.

There is another life-saving trick of the tiger mosquito. Her biting is generally painless while she is at it. We hardly know that we are being bitten unless we actually happen to see the creature at her meal, whereas with some other mosquitoes we may feel their bites as soon as they are made, and so have time to avenge ourselves on the invaders. While enjoying herself at her meal, a mosquito is generally off her guard, at which time a slap at her may meet with more chance of success. As this is a rather critical period for the mosquito, the painlessness of the tiger mosquito's bite serves in not attracting fatal attention during her weak moments.

The local breed of tiger mosquito has often an annoying habit of not completely satisfying her appetite at one bite. It may take several nips in rapid succession before the effect of the first bite is felt, so that, by the time we commence to feel the itching of the first, we may find that we need to apply soothing lotion to several separate lumps. Or she may dart off and attack us later again and again, so that the repeated activities of but a single insect may give us the impression that there is a battalion of tiger mosquitoes in ambush in the room.

This common habit of our tiger mosquito in taking short intermittent bites may be one reason why we do not feel her attack while it is actually taking place. The irritating effect of a mosquito's bite is due mainly to the injection of an anti-coagulating substance from the salivary glands of the mosquito which helps in maintaining a free flow of blood while her sucking apparatus is in operation. This is the substance left

behind which causes the irritation and swelling subsequent to a mosquito's bite, rather than the mere puncturing of our skin at the initial attack. We usually start suffering from this after-effect very soon after the mosquito's bite. But by the time we commence feeling the irritating effect from the short bite of a tiger mosquito, the pest has safely made her escape, whereas the long bite indulged in by a member of some other less cautious species may betray her while she is still at her gory meal. We have seen a specimen of our rather sluggish local species of *Anopheles*, or malaria carrying mosquito, so intent on filling herself with blood that she would not budge unless she was actually swept away. Even our local night-biting *Culex* is less agile than our tiger mosquito. It is rather intriguing to see specimens of *Culex pipiens* engorging themselves so full of blood that they barely manage to roll over on their backs after having partaken of their meal, not being able to fly off with such a heavy load of blood within them. Mosquitoes which do their biting only under the cover of the darkness of night, when we are usually fast asleep, may not need to develop such adaptability as the day-biting tiger mosquito.

Another adaptation of the tiger mosquito to day-biting habits is her elusiveness. She does not believe in making herself noticeable if she can help it. The night-biter can afford to fly gently about in the darkness all over the room. When the lights are on at night, we can at times actually grasp one of these night-flyers while she is in the air. But try and catch a tiger mosquito in broad daylight while she is on the wing and you will find it a strenuous game of hide and seek. When it looks as if you surely must have caught the pest, you are faced with an empty palm. These little compactly built creatures are able to execute aerial acrobatics that are quite beyond us. Instead of floating about in the air, where they will be easily seen in broad daylight, they will be darting swiftly about from one dark corner of the room to another. Under the dining room table is a favourite rendezvous for them.

We may seem to be giving undue credit to the tiger mosquito for her intelligence at beating us time and again in a battle of wits. However, it is simply a matter of instinct on the part of the little pest. The mosquito is born with her bag of tricks, so to speak, in order that she may by automatic action save her life when it is threatened.

From long association with man, the tiger mosquito evidently has acquired the knack of stealing meals off us with little for us on our part to say or do in the matter. Having acquired a day-biting habit, the odds against the survival of the species in the process of evolution were great. Thus arose a need for greater adaptability to the ways of her host if the race of the tiger

mosquito was to be perpetuated. In adapting themselves for generations to the safest ways of satisfying their appetites off man without being exterminated in the attempt, certain species which were most successful in the past have handed on their best tricks to posterity. The mechanism of all this may be explained by the laws of the survival of the fittest and the passing on of acquired characteristics which have proved useful to the race. On the other hand one can explain it by a series of sudden mutations. In fact, we have here a debatable point, and one which has divided naturalists into two schools of thoughts with respect to somewhat more ponderous topics than the tiger mosquito. The final result, however, is the same, and unfortunate and inhuman as it may seem, we have here in this lowly and virulent species an unifying example of the success of the policy of continuously "getting away with it."

The tiger mosquito appears to have arranged her propagation to suit her domestic surroundings. Other mosquitoes, such as our common *Culex pipiens*, usually do their mating out in the open spaces. The so-called swarming of mosquitoes, taking place about the time of sundown, is doubtless a familiar sight to most Shanghai residents. One usually sees this performance over one's lawn or over the grassy spaces of the public parks. These merrily dancing creatures are all males of the species. The young dandies apparently are showing off what fine fellows they are to their prospective mates, who are likely to be enjoying the spectacle somewhere about. The dance of the male mosquitoes is a dance of courtship. Watch closely one of these swarms about the time of twilight. Now and then you see one of the females lurking nearby darting into the swarm of males and making off with her mate. It is a question whether the approaching bride does the selection once she has flown into the swarm of young dandies or submits to some chance male that claims her for his own. Once the couple are mated, and it takes little time for this public ceremony to be over with, together they float off in a love embrace on their mosquito honeymoon, leaving behind the swarm of dancing suitors.

The tiger mosquitoes, however, prefer to confine their mating to the privacy of their temporary host's residence as being more suited to their domesticated nature. No wild gypsy dances and merry making in swarms of hundreds for them. The males go about their ways, each by himself, and select their mates, or are selected, as the case may be, in solitude. This simpler form of mating, since it needs little space, can well take place within the confines of our houses, as the tiger mosquitoes would rather not wander about too far from their source of nourishment.

The simplicity of this form of mating habit

makes it easy to breed generation after generation of tiger mosquitoes in the laboratory. They will mate even in the narrow confines of a test tube, whereas it is quite another matter to try to breed our other Shanghai species in the laboratory. There is not space enough indoors for the males to form into swarms. These less domesticated mosquitoes usually will not mate unless they can enjoy their own free ways of courting.

In order to make sure that her offspring will not have to seek far and wide for possible nourishment the tiger mosquito generally lays her eggs in the immediate vicinity of our houses. Instead of looking about for some wayside ditch or pool for a suitable breeding place, as many of our other species do, the tiger mosquito prefers not to venture so far afield. Almost any sort of container about the house which happens to be holding some water may be chosen. In our study area in the Kaochiao district, we find them breeding in discarded jugs.

Apparently knowing that her young will need to be wriggling about in their aquatic home for a week or more, the tiger mosquito generally will only choose those containers in which the water will not dry up for a few days. So one is not likely to find the larvae in shallow pots or tin cans fully exposed to the sun. Those resting in some shady spot in the yard are preferred.

Any kind of container will do—old cans, broken pots or pans, jam jars, pickle bottles and other odds and ends that may be lying about in out-of-the-way corners of the yard or in some empty lot nearby. These are likely to be filled with water when it rains, and, if the water is not evaporated soon enough, they are likely to be breeding the summer supply of tiger mosquitoes. Barrels or *kongs* containing water for drinking or gardening purposes can breed these pests in sufficient abundance to provide the entire neighbourhood with more than enough of this form of summer annoyance. Empty flower pots in and around greenhouses should be inspected with care. The saucers of water beneath rockeries or pots of orchids are favourable breeding sites for the pest.

Even within the heart of the city we may find tiger mosquitoes bothering us in our offices. Considering how well these domestic pests can make themselves at home everywhere, this is not surprising. They may be breeding in stopped-up gutters about the buildings, or in empty pots lying about. The flooded concrete foundation spaces beneath some of our buildings may be a prolific source of larvae when there happens to be access to such unnoticed collections of standing water. Even spittoons about the building may serve as the home of these wrigglers, especially when janitorial diligence is lacking.

Some of our local forms of mosquito are rather particular in their choice of breeding places and generally are found only in certain types of water. For instance, the big black mosquito, *Armigeres obturbans*, the giant of our Shanghai species, usually will select water that is heavily polluted with organic waste, being found in the open latrines of farmers' houses or in their fertilizer kongs. Our malaria carrier, *Anopheles hyrcanus* var. *sinensis*, is seldom found to breed in artificial containers, preferring the water of rice fields, irrigation ditches and ponds. Our tiger mosquito also shows her own peculiarity in the choice of breeding places. We will not find her larvae in ditches and other types of natural ground water. She appears to avoid depositing her precious young ones where there would be a thousand and one dangers for them to face, not the least of which are ferocious water beetles, dragon-fly nymphs and the many larvae-eating fishes that regard them as so many dainty morsels to be enjoyed. Apparently she feels safer in depositing her eggs in an old tin can of left-over water, or some such discarded receptacle; in fact she counts on human carelessness in the most cynical manner.

That the past may help to explain the present applies to the antics of our tiger mosquito as well as to human behavior. The question arises as to how it came about that tiger mosquitoes developed such a preference for breeding in artificial containers. Let us consider where they were likely to be breeding before man, in his prehistoric days, invented pots and pans, certainly long before man cast his discarded tin cans at his neighbours cat. We submit that the probabilities are that they evolved by breeding in tree holes filled with rain water, and that they followed our distant hairy ancestors with interest when they commenced discarding wooden utensils for earthenware receptacles. Ever ready to profit by human failings and untidiness, the wretches have simply continuously regarded the domestic receptacles of man in the same light as the discarded rinds of fruit or cracked coconuts of our simian forefathers. Even to the present day tiger mosquitoes are rather attached to tree holes or the hollows in cut bamboos. They do not like ground water at all.

A somewhat similar theory has been advanced to explain how the yellow fever mosquito, *Aedes aegypti*, came to develop a like preference for such artificial sorts of breeding places. As the tiger mosquito is a close cousin of this infamous public enemy, a similar trend in the evolution of instinct in this direction may have occurred in both lines of the family.

In the foothills of Hangchow and other parts hereabout the tiger mosquito can be found breeding in prolific numbers in bamboo holes.

The many stone holes on the rocky hills around West Lake are also favourable spots for this pest. We have found them breeding contentedly even in the odour of sanctity in some of the oblong granite troughs used as incense burners in the courtyards of temples.

Taking advantage of the tiger mosquito's preference for tree holes, we have set up some bamboo traps in our study area. By lining the bottom of these traps with dead leaves and filling them with rain water, we are assured of a good supply of these larvae whenever we need them for our laboratory investigations.

The tiger mosquito lays her eggs singly, instead of in groups in the form of a floating raft, as is the case with *Culex pipiens*. She usually deposits her eggs, which are without side floats, on the side of the container, about the edge of the water. *Anopheles'* eggs, which are deposited on the water surface, are provided with floats to keep them from sinking. The eggs of the tiger mosquito can stand a long period of dessication. When it rains again after several weeks of dryness, the eggs will still be viable and the larvae will be hatching out as if nothing had happened. This adaptability of its eggs enables the species to tide over any summer, no matter how dry it may turn out to be.

The young of the tiger mosquito require very little in the way of nourishment. They can flourish even in containers that are used for storing drinking water. By leaving some tumblers of clear water undisturbed in dark corners around our field laboratory, we usually find tiger mosquito wrigglers in them after a week or so. One would wonder how these larvae can thrive without any visible sign of food. However, they are able to obtain sufficient nourishment by feeding on the millions of microscopic bacteria that are sharing their aquatic homes with them. They also may be extracting soluble forms of organic nourishment from their liquid environment. Mosquitoes that emerge from such ill-nourished larvae are usually smaller in size than those that have been better fed during their young days. The tiger mosquito's larvae can thrive even in the water in old tree holes that is so saturated with decaying vegetation that it is just about coffee-coloured. Their ability to withstand this wide range of conditions enables the species to survive where other more fastidious mosquitoes would find conditions uninhabitable.

The elusiveness of the tiger mosquito begins in extreme youth. The larvae are not easily seen when we go about looking for them. As soon as we approach their breeding place, they dart down to the bottom of the water before we are near enough to see them. They usually rest in a position about perpendicular to the surface of the water. This enables them to head towards

the obscurity of the bottom debris of their breeding spot all the sooner when danger approaches. The larvae of *Culex pipiens*, resting at an acute angle to the water's surface, are much slower in response to danger. Having made their escape, the tiger mosquito larvae hide themselves under dead leaves or any other debris that they can manage to find. They can thus remain hidden for quite a long time, but, sooner or later, they are forced to rise to the water's surface for more air. Then is the time to scoop them up, if it is desired to make a collection.

Receptacles that may be breeding tiger mosquitoes should be turned upside down if they cannot be disposed of immediately. Just emptying off the water may not be doing away entirely with their stocks of wrigglers. The larvae of the tiger mosquito, having all hidden themselves in the bottom debris at the first sign of disturbance, are mostly concentrated in the last few ounces of water that may remain in the container if we do not manage to empty it completely. Even then these tenacious wrigglers may be clinging to the moist bottom debris. Unless they are entirely dried up, another fall of rain, and they will be wriggling about happily again. One way of preventing tiger mosquitoes from breeding in water barrels which cannot very well be emptied, such as those used in water storage for gardening purposes, is to keep a few mosquito-eating minnows in each. These will take good care that any larvae which may hatch out will not have time to wriggle about very long.

The tiger mosquito is not only one of our worst Shanghai summer pests, but potentially is a dangerous disease carrier as well. In some parts of the world this particular species can be a transmitter of dengue. This is popularly known as break-bone fever, as one who is unfortunate enough to be bitten by a mosquito infected with this virus, will be likely to feel as if he were on the rack. Dengue is not uncommon in Southern China, as cases have been annually reported to occur in Foochow. Fortunately in Shanghai, we hear little of it, but it has been found to occur in Hangchow and Ningpo. As we have plenty of tiger mosquitoes in this region, the possibility of dengue spreading in Shanghai is one not to be disregarded.

The tiger mosquito may also be a potential carrier of a more deadly disease, yellow fever. Experimental studies carried on by Dinger at Amsterdam, working with laboratory monkeys, have proved that *Aedes albopictus* obtained from Java can transmit this dread scourge of mankind from a diseased to a healthy animal. This species is thus under rather strong suspicion. Should the tiger mosquitoes of this part of the world likewise be found to be possible transmitters of yellow fever, then we must consider it as a dangerous pest. Although the endemic area of yellow fever in West Africa is a long way off, there is just the possibility that aerial transportation, which is rapidly developing, will afford a link by which the virus might be introduced into China.