ANOPHELES LUDLOWII (*A. SUNDAICUS*) SURVEY IN AND AROUND CALCUTTA.

By P. SEN, *M.Sc.* (*Cal.*), *Ph.D.* (*Lond.*), *D.I.C.*, *Entomologist I/C, Anopheles ludlowii Survey, Bengal Public Health Department.*

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INTRODUCTION.

The earlier records of *Anopheles ludlowii* (Theo.) from Bengal was that of *Anopheles sundaicus* (Rodenw.), as we know now, and is regarded as the correct name for this mosquito as already pointed out by Covell (1932). It has received so much publicity by its former name of *ludlowii* which, although not accepted by recent authorities, is still used in official records as the name is better understood by local bodies. The species *Anopheles sundaicus* normally breeds in water containing salt in various concentrations, and is a virulent carrier of malaria. In Bengal it has long been known as a coastal species, being mainly restricted to the Sundarbans, but within the last six years the breeding of the species has been more and more intense in the inland areas. Thus, barring the exceptional record by Brahmachari of the species breeding temporarily in the Campbell Hospital tank within Calcutta in 1912, this mosquito was not known to have established itself anywhere nearer to Calcutta than Port Canning on the Matla River about 28 miles from the city prior to 1930, when for the first time the species was recorded by Iyengar (1931) from Budge-Budge and Chengail, both being situated on the River Hooghly but on opposite banks and within 18 miles of Calcutta. This invasion in 1930 caused a heavy outbreak of malaria in both Budge-Budge (the spleen rate rising as high as 91% in some places) and Chengail (the spleen rate jumping to 74% in the worst places). A natural apprehension was felt that, should the species spread further northwards and ever establish itself in the Salt Lake area east of the city, the health and prosperity of Calcutta would be endangered. The then Director of Public Health, Bengal, therefore advised the Local Government that a detailed investigation was necessary in order to trace the distribution of the species along the various tidal rivers and swamps in the neighbourhood of Calcutta. As a result of this move, a systematic survey has been made to locate the breeding places of the species since 1931. The survey reports prepared by me and my colleagues from time to time have been utilized by Senior-White (1937) in compiling the distribution of the species in a very recent paper.

DISTRIBUTION OF THE SPECIES IN LOWER BENGAL.

Almost from the very beginning *Anopheles* (*ludlowii*) *sundaicus* survey work has been proceeding along two distinct lines, (1) the river-side areas

including the places served by the rivers Hooghly, Bidyadhari, Ichhamati and the various channels leading from these, and (2) the Salt Lake areas to the east of the city including the fringe areas of Calcutta. There are several railway systems intersecting the river-side areas and the survey parties were despatched along each of these lines in successive periods almost regularly.

River-side Areas.

The first evidence of the prevalence of the species in other areas outside Budge-Budge and Chengail along the River Hooghly was discovered in June 1931, almost immediately after the commencement of the present investigation, when the species was recovered from Falta (spleen rate 12·5) proper and about a dozen villages surrounding it in the lower reaches of the River Hooghly on the same bank as Budge-Budge. At the same time a large number of infected adults of the species was detected as being transported through K.F. Ry. trains to Majerhat, a little beyond Alipore from this zone. The Falta focus extended to Shivanipur, Sirakole and finally to Bishnupur about 10 miles away in 1934. The upper limit of the species along the left bank of the river appears to be Shamnagar which is 19 miles away, where the species in its winged form occurred as far back as 1930 (Iyengar, Covell), but the breeding in this area could not be traced until 1933. The same year adults of the species were found in Pujali and Mayapur,[1] a place of commercial importance nearly 5 miles south of Budge-Budge, which was under the effective control of the Government anti-*ludlowii* staff and the spleen rate to-day has come down to 2·6 only. A little further down a fresh focus appeared in 1934 at Godakhali almost half-way between Falta and Budge-Budge, thus by 1934 the whole tract between Falta and Budge-Budge being involved.

The species was not quiescent in the upper reaches of the River Hooghly, and surveying above Calcutta it was found to be breeding in 1933 in Dakshineswar not far from Calcutta, being within 9 miles, and having direct communication with the city by bus and steamer services. There was some lull after this, and it was only in 1935 that active dispersal of the species took place along the upper reaches, when Cossipur (Sinthi), Dum-Dum which is within 5 miles (spleen rate 10·0 to 13·0), Khardah (12 miles) and Ichhapur (17 miles), all very important industrial areas, were infested with the species. The same year adults were caught at Chitpur Lock Gate within Calcutta near Baghbazar. Panihati and Sodepur (10 miles away) showed some breeding in 1936. This completed the infestation of the entire riverine tract between Calcutta and Shamnagar covering an area of 19 miles. Madhyamgram (11 miles) along the Bongaon section of the E.B. Ry showed some casual infestation in 1936.

It seems curious, however, that in spite of the widespread distribution of the species from Budge-Budge to Falta and from Calcutta to Shamnagar

[1] Breeding detected in 1936.

along the left bank of the Hooghly, the tract lying between Budge-Budge and Calcutta was free from any breeding until the current year, when Akra (13 miles) nearly half-way between Budge-Budge and the Garden Reach area and within a short distance of the Calcutta shipping range was involved in the breeding.

From previous records it is evident that the species was breeding in Chengail area (17 miles from Howrah) in 1930 (Iyengar, 1931). Since then evidence of the distribution of the species more generally has been recorded. The first finding by the newly constituted survey party on this bank was at Uluberia, nearly 20 miles away from Calcutta on the B.N.Ry. and about 3 miles west of the old, i.e. 1931, focus of Chengail. This detection was made following the capture under interesting circumstances of adult *A. sundaicus* in a Uluberia train at Howrah, thus providing another example of the transportation of the species by train. The following year 1932 was very favourable for the dispersal of the species in the area. By 1933 the Chengail focus had extended both east and west to Bauria (15 miles) and Fuleswar (19 miles), followed by an epidemic of malaria in the latter place (the spleen rate rising to above 15 per cent) which was formerly a healthy area, and infective stages of the mosquito were recorded. These findings were of great concern to the B.N.Ry. organization, since the health of the whole Bauria-Uluberia section of the railway was in danger, and the railway had therefore to take up active control measures for this area. The previously existing Government control work at Chengail, which was originally taken up to safeguard the interest of the jute mill owners, merged into that of the railway control measures.

In 1933 an important detection was made of the widespread distribution of the species at Belur in close proximity to the E.I.Ry. colony at Lillooah and within four miles from Calcutta. This finding resulted in the formulation of the first anti-*ludlowii* scheme at Lillooah (4 miles), a station of great importance under the E.I.Ry. The upper limit of this species along this bank was also established in the same year by the detection of the species breeding in Mankundu (19 miles) and of adults only in Telenipara under the Bhadreswar Municipality, being almost opposite Shamnagar on the other bank. Thus, from the beginning the species was breeding in areas widely apart, and it was not until the next year 1934 that the Belur focus spread further inwards to Uttarpara (6 miles), a distance of 2 miles from Belur. Further progress was made in 1936 when the species was established in Konnagar about 9 miles from Calcutta. An addition was made to the list by the finding of the species in Baidyabati about 15 miles from the city during the current year. Thus, practically the entire tract between Calcutta to Mankundu and as far as the border line of Chandernagore is within the range of *sundaicus* invasion.

Along the B.N.Ry. tract further dispersal occurred in 1935 when adults were recorded from Andul, about 8 miles away, and Sankrail (10 miles), which is almost opposite Akra on the left bank of the river. Both in Sankrail and Akra (E.B.Ry.) the species has been breeding during the current year.

As regards the nature of dispersal of the species northwards towards the city from Port Canning (28 miles), which appeared to be within the *sundaicus* zone, it began as early as 1909. From the very year of commencement of the special survey work in 1931, the species was recorded not only from Port Canning and several villages near it, but from as far northwards as Piali village, about 21 miles away, and the villages Bansra and Manasapukur under the Protapnagar Police Station on the Bidyadhari River. The species spread to Champahati (20 miles), a mile to the north of Piali station, in the year 1932, and was generally distributed along the courses of the rivers Piali and Bidyadhari. Taldi (23 miles) and Lakshmipur, between Port Canning and Piali, were also heavily involved in the breeding. Thus by 1933 it was discovered that the portion of the country between Port Canning and Champahati was breeding the species profusely and the endemicity was high in the area, being above 50 per cent in some places. Ghutiari Sharif and the neighbouring villages along this section became involved in 1935.

Another important focus, also detected in 1931, was that of Hashnabad, 44 miles away from Calcutta, where the species was breeding in six villages including the influential town of Taki (42 miles). An additional focus along the B.B.Ry. line cropped up in the year 1932 when the species was recorded from Basirhat and Toparchar, about 36 miles away, in large numbers, and by 1934 these merged into one huge tract of *sundaicus*-infected area by the species starting to breed in the intervening stations between Taki and Basirhat. The distribution of the species in the various *bheels* round about Haroa Khal station, about 11 miles away along the same line but leaving a considerable gap from Basirhat, was detected for the first time in 1934. Infected specimens have been known to be transported to Shambazar (Calcutta) through the B.B.Ry. trains from time to time.

The same year, i.e. 1934, gave a more thorough picture of the distribution of the species along the various tidal rivers and *khals* on the north-east of Port Canning and also along the bank of the Ichhamati River past Hashnabad as far as Swarupnagar. The vast undeveloped water-logged area bounded by the river Bidyadhari and the Gobra Khal, involving the three important police stations,—Port Canning, Bhangore and Sandeskhali—was all a *sundaicus*-infested zone. Several villages on the bank of Ichhamati, including Baduria and Swarupnagar, were also involved by 1934.

Active dispersal of the species was revealed as a result of our survey in 1935 in the tract lying between Baruipur, 16 miles from Calcutta, and Diamond Harbour (37 miles south of Calcutta) on the one hand and Joynagar (31 miles to the south) on the other. The invasion of *sundaicus* in these areas resulted in an outbreak of malaria at Baruipur and Joynagar in the autumn of 1935, the spleen rate reaching above 40·0 per cent. *Sundaicus* invasion along the line was more intense in the following year, when the species was recovered from a village (Noapara) near Sonarpur (11 miles) and the entire tract from Garia (8 miles) to Dhakuria (4 miles), the last-named place being

within one mile of Ballygunge, was involved. Adult *A. sundaicus*, evidently emanating from the Dhakuria focus, was actually reported by Senior-White from Ballygunge, a suburb of Calcutta, during the last year.

Salt Lake Area.

The history of the establishment of the species in the Salt Lake area to the east of the city is much more interesting. An eye was always kept over this area from the commencement of the survey work in 1931. Nothing, however, beyond the capture of adult *A. sundaicus* at Kristopur on the eastern border of the lake, from a boat which evidently passed through the *sundaicus*-infested zones on her way to the city, thus providing an example of a good means of dispersal of the species by the country-boat, was recorded in that year. It was only towards the end of 1932 that any active breeding of the species could be detected from the lake area and that too only from the portion bordering Noaputty close to Kristopur on the eastern shore. The authorities grew more anxious to protect the city from an invasion through this route, but before any active measures could be taken the species made headway towards the western border of the lake adjoining the eastern fringe areas of Calcutta, and the entire mass of the brackish water collections from Chingrighata to Noaputty, a stretch of about 12 miles, was under *sundaicus* occupation by the end of 1933. Once established in the lake, the onslaught of the species was easier, and in the same year the species actually started breeding in Nebugola under ward 28 of the Calcutta Corporation. The apprehension of *sundaicus* malaria in the city was justified, since in July 1933 an epidemic of malaria broke out in that ward, the spleen rate rising to 20·0 per cent, and infected specimens of the species to the extent of nearly 7·0 per cent were recorded from the area. Before the close of the year 1933, Pagladanga in ward 18 was also involved in the breeding of the species. More and more infiltration occurred during the succeeding years, and in the years 1934 and 1935 the species also invaded the most interiorly situated villages of the lake as well as parts of ward 29 of the city. More wards of the city were involved in 1936 when heavy breeding was recorded from Tangra, a populous part of Calcutta, in addition to Pagladanga in ward 18, where the species was prevailing from 1933 as well as from Dhapa and Topsia on the south-eastern fringe area of Calcutta. The species again justified its reputation by causing an unprecedented epidemic of malaria in this newly invaded locality of Calcutta in the autumn of 1936, when the spleen rate in some places went as high as 96 per cent. Infectivity in the species was recorded of about 3 per cent during November of the same year. The current year saw the spread of the species in Ghughudanga and Satpukur under ward 31, and we are apprehending an outbreak in the near future in this locality also. This brings to a close the position up to date of *sundaicus* distribution in and around Calcutta, but the survey is by no means

complete and the breeding of the species is being detected from most unexpected spots as time passes.

In conclusion, it may be mentioned that the species is migrating more towards human habitations year after year. This migration has been helped in many places through the agency of transport either by train, country-boat, or perhaps by bus as has been sufficiently indicated from the catches made at the different railway stations, such as Majherat, Sealdah, Shambazar and Howrah, from time to time, as also from the lock-gates at Baghbazar and Kulti. Once transported near human habitations the species takes to its new environment and its great adaptability to various ranges of salinity, even to fresh water, is an additional advantage to the species for establishing itself in a new area. In recent years the species, although normally a brackish-water breeder, has established itself in many places in what may be considered as fresh-water breeding places. To-day it is breeding freely on the one hand in the highly brackish or salt waters of Diamond Harbour and Port Canning (Matla), the salinity varying from 600 to 1100 parts per 100,000, as also in the practically fresh waters of Mankundu or Shamnagar on the other hand, having a salinity of 5 to 7 parts per 100,000. It has been a common experience of workers in estuarine and deltaic faunas that there is always a transformation acting on the life of animals which brings about a change in their activities from sea to fresh water, and *sundaicus* offers a unique example in support of such observations. The heavy rainfall, large tracts of tidal areas with embanked portions of water, uniform soil condition and high temperature with heavy moisture contents have all been helpful in the distribution of the species. The attack of inland waters by the species in the different years has been through different routes and the species when it first invades an area exhibits a somewhat territorial phenomenon, having a distinctly localized distribution, but as years roll on these areas, as we are gradually realizing, have been practically merging into one another, and truly ' the invasion of fresh water from the sea is a slow, hard fought struggle ' (Pearse, 1932).

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