3. HISTORICAL PERSPECTIVE OF MALARIA PROBLEM IN KORAPUT DISTRICT
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Koraput district of Orissa state in the eastern ghat regions is probably one of the oldest foci of malaria in India. Though the earliest records on malaria date back to early part of 20th century (Stephens and Christophers, 1902; Perry, 1914), it is likely that malaria existed in this locality for centuries from ancient times (Venkat Rao, 1949b). The very fact that several aborigine tribes have been able to survive with their original cultural practices undisturbed is supposed to be due to the scourge of malaria (Perry, 1914). For the number of wars and invasions this country had faced (Venkat Rao, 1949b), the survival of these aborigines would not have been possible but for malaria, the fear of which, virtually kept away all other races from the area. This area came under the British regime since 1839 and formed the northern most part of the 'Agency areas or tracts' of the 'Madras Presidency' as the area was administered by a special Agent of the Governor of Madras. The area came under the Koraput district, when the state of Orissa was formed in 1936 (Senior White, 1937a). In the language of malariologists of early part of the century (Perry, 1914; Senior White, 1937a; 1938), this area has been referred to as 'Jeypore hill tracts, since it formed a part of Jeypore princely state.
3.1. GRAVITY OF MALARIA SITUATION:

This area has been dreaded for malaria and black water fever from the last century. The earliest official record of 1869 (in the 'Manual of Vizagapatnam District' as quoted in Anonymous, 1969) reads, "there was scarcely a man who visited these parts, who did not return with an enlarged spleen or liver, more or less affection of head, making business irksome and with a constitution broken down". The official gazetteer of Vizagapatnam district (Francis, 1907) reads "Malaria prevails throughout the whole Agency. The worst localities are perhaps Bism Cuttack side, Malkangiri taluk, and the Golconda hills. The worst season of the year for the disease is undoubtedly the rains, which is contrary to rules in such matters. The least unhealthy period is November up to the first thunderstorms of April. Black water fever is common among European residents in the hills. The hill people themselves seem to suffer little from Malaria". An administrative report in 1969 says "Immigrants used to suffer both from ordinary forms of malaria and from its severe complications, black water fever and cerebral malaria....." (Anonymous, 1969).

The notoriety of malaria in this district has been compared to that of Panama canal zone (Perry, 1914). The following description also gives an idea of the situation that prevailed in the early part of the century.

"Most notorious unhealthy tracts are of this character and it is such areas which constitute the known endemic foci of black water
fever........Among better known areas of this kind may be mentioned the Sigur Ghat,......the Jeypore hill tracts north of Vizagapatnam and hill regions and forests of Orissa and neighbouring parts (Singhbhum)" (Christophers and Sinton, 1926).

"There are malarious tracts of general evil reputation in many parts of India. The Terai of the Eastern Himalayas, the Northern slopes of the Khasia hills behind Guwahati, Lahore cantonments (Mian Mir), most of Chota Nagpur in Bihar and Orissa, the foot of Nilghiris, to name but a few, are all notorious for their 'feverishness'. But it is probable that no locality in whole of Indian Empire has such a dreadful reputation as 'The Agency', no doubt that this is the largest hyperendemic tract in the Empire" (Senior White, 1928).

The gravity of malaria situation in this area is also reflected in the difficulties encountered during the construction of the railways across the hill tracts (Senior White, 1928). It was planned in early part of the 19th Century (around 1825) to build a railway line (309 mile stretch) connecting Vijayanagaram (then in Madras Presidency, presently in the state of Andhra Pradesh) and Raipur (then in Chota Nagpur province and presently in the state of Madhya Pradesh) cutting across the Jeypore hill ranges in Rayagada subdivision of the present Koraput district. The first part of the stretch (approximately 65 miles) between Vijayanagaram and midway between Parvatipuram and Rayagada is a plain land south east of the Jeypore hill ranges. The
second stretch which passes through the hill ranges begins from near Rayagada (almost 10 miles south) and continues almost up to Titlagarh. The summit of the ghats is situated near about 'Bisum Cuttack' in Vijayanagaram side. The story of surveying this region and laying the railways speaks of the unique malaria situation in this hill ranges. The whole route was surveyed for the first time by the then Railway officers and Engineers between 1883-86. Two years were spent before a route was finally found on the hill ranges practicable for railways, but apparently the entire team was lost along with their records. Nobody knew what casualties occurred to this team. The grave of one of the engineers was discovered by Senior White in 1926, 20 miles south of Bisum Cuttack. A second survey was started in 1897 and this also broke down due to malaria after traversing 40 miles in the hyperendemic tract (99 miles from Vijayanagaram). The third party started a resurvey in 1907 but again broke down after travelling barely 2 miles ahead of previous team. A fourth party resurveyed the 24 mile stretch across the summit in 1923 only when railway communication was established in the first stretch between Vijayanagaram and Parvatipuram. (During the same time another survey between Rayagada and Jeypore had cost the lives of two officers. Who knows how many labourers and contractors have also sacrificed their lives!). During 1925, the actual construction across the summit started and it was possible because of the expert advice of Senior White (Senior White, 1937a). However, the entire railway connection between Vijayanagaram and Ranchi was established only after the DDT became available around 1946 (Ramachandra Rao, 1984). This
description justifies the earlier comparison of the evil reputation of malaria of Jeypore hill tracts to that of Panama Canal (Perry, 1914). The malaria situation in the hill tracts was also reviewed by Rao in 1930. He states "the Agency tracts continue to be dreaded as death trap and no individual would even care to go either for love or for money, unless he happens to be a Government servant, who, though under no definite stipulation, is obliged to serve his turn of 'Agency Service'".

3.2. EPIDEMIOLOGICAL ASPECTS

3.2.1. Endemicity:

Though Stephens and Christophers (1902) studied the spleen and parasite rates in Koraput part of the district, their results are not available. Most extensive studies on parasitological and epidemiological aspects of Malaria in the Jeypore hills were carried out by Perry (1914). (He spent more than 14 months in the area, during 1911-12). In his classical work he vividly described the epidemiology of the disease in different areas. His work on the difference in response to malaria infection among different tribals was one of the earliest attempts to understand the role of immunity, as it had a bearing on epidemiology of this disease. He published his initial results in 1911 (Perry, 1911). He recorded a spleen rate of 15% and an
endemic index of 61.1 (29% uncertain but mainly quartan malaria, 16% undoubted quartan, 13% Benign tertian and 3% malignant tertian). He published the detailed results later on (Perry, 1914). The salient findings of his study are given below.

(i). He classified the 'Jeypore hill tracts' into three areas based on physiography and altitude. He recorded high spleen rates in all these zones. The lowest (Malkangiri) and the highest (Koraput) plateau recorded higher spleen rates (90.7% in Malkangiri and 89.1% in Koraput) compared to the middle plateau of Jeypore (69.9%).

(ii). He believed that 'clearance of jungle' and extensive rice cultivation were responsible for relatively lower spleen rates in the middle plateau.

(iii). He compared the malaria problem between tribals and relatively recent immigrants. Regarding the immunity in tribals he writes "If a European were to go and live in one of these villages, amongst these people, without medical treatment and without protection from mosquitoes, his health would rapidly be shattered and he could scarcely hope to be alive at the end of two years. If we bear in mind we shall realize at once the reality of immunity in malaria. The aborigine harbours large number of malaria parasite in his blood when in childhood but
is in a high degree tolerant of its presence and immune to its effect." He postulated that the high degree of sufferings on the part of the immigrants was due to the following factors: a) mixed infection of more than one parasite, b) high inoculation rate, c) high dose of inoculation and, d) high degree of virulence of the parasites.

In the malaria map of India (Christophers and Sinton, 1926), the Jeypore hills area was classified under "Probable hyperendemic areas". The hyperendemicity was associated with the presence of low jungle or forest covered hills and foothills.

Viswanathan (1951) studied the parasitological aspects of the disease during 1928 (but did not publish his results until 1951) with special reference to relationship between immunity and endemicity. He confirmed the findings of Perry (1914) in that the levels of immunity (as measured by spleen and parasite rates) varied between ancient primitive tribes (Gadabas, Porojas and Kondhs) and relatively recent migrants (Dombs and Malis). His study in Jeypore hills has contributed to the concept and understanding of immunity in malaria. Based on the age specific prevalence of parasitaemia he observed that even with the same inoculation rate, two primitive groups of communities could react differently. In one group there was greater degree of tolerance to the effects of parasite invasion even in childhood and an almost complete freedom in adult life from malaria. In the other group, children were
affected to a far greater extent and adults perceptibly. He postulated that there existed different parasite thresholds for fever among the different communities. While this threshold was very low in the immigrants, who developed fever even before parasites could be detected in peripheral blood, the same for the aborigine was higher (though there were differences even between these communities).

He has also discussed the difficulties in grouping areas into the degrees of endemicities based on spleen rates as proposed in the League of Nations Malaria Commission in 1940 and Expert Committee on Malaria of the WHO in 1950. He emphasized the need for considering the difference in degrees of immunity in different population even when exposed to similar degree of inoculation rates, when classifying areas for their endemicity. Therefore he proposed another classification of degrees of endemicities based on the patterns of age specific parasite rate. He felt that the so called holoendemic areas (with child spleen rate above 75%) could be reclassified into two groups: (a) holoendemic: spleen rates in children (2-10 years) above 75% and high adult spleen rate; (b) superendemic: child spleen rate above 75% with very low adult spleen rate. This would mean that though both the groups have high degree of immunity, in one the adults are almost free from morbidity (superendemic situation) as in the case of primitive aborigines.

Trying to explain the very high levels of parasitaemia in young children 2-5 years old, he postulated that racial immunity had two
components. One passively inherited, and, the other actively acquired. The first was not antiparasitic but was directed against the effects of parasitaemia, and the second not only neutralized effects of parasitaemia, but was also antiparasitic. Thus during childhood one observed high rates of parasitaemia without fever.

In his study on malaria in Bengal-Nagpur Railways, Senior White (1928) had examined over 4,000 children for splenic enlargement, spread over 117 villages between Parvatipuram and Raipur. Spleen rate was highest in villages in Bisnup Cuttack area (average 60.11%), the northern most frontier of the then 'Agency area' of Madras Presidency. The name 'Bisnup Cuttack' literally means Poison fort and justifies the same due to its notoriety for malaria.

Venkat Rao (1949b) has reviewed the malaria situation in Orissa prior to launching of the National Malaria Control Programme. He compared the malaria situation of Orissa with Malaya peninsula. According to the malaria situation, Malayan Peninsula has been classified into hills and the plains. He made this comparison since Orissa could also be classified into two similar regions:

(i). the hill tracts, comprising the entire Koraput district and large parts of Sambalpur district and

(ii). plain areas, rest of the parts of the state.
He presumed that the hill tracts have always been malarious while in the plains it was relatively recent (after 1872). Malaria was hyperendemic in the hills with spleen rates ranging between 70 and 90 percent. Black water fever was present over a wide area in the hills.

It is worth noting that the Koraput district has continued to remain highly malarious from early part of the century till date. This is evidenced from the malaria maps of India prepared at different times (Christophers and Sinton, 1926; Singh et al., 1952; Kondrashin and Rashid, 1987; Sharma, 1987).

3.2.2. Distribution of parasite species:

Perry (1914) has recorded three species of human malaria parasites in the Jeypore hills. He observed _P. malariae_ (Quartan) in 19%, _P. vivax_ (Benign tertian) in 17% and _P. falciparum_ (Malignant tertian crescent) in 6% of cases and the rest could not be speciated. A majority of parasite positive cases had only rings (Possibly _P. falciparum_) which could not be morphologically differentiated at that time. Although _P. malariae_ prevalence was apparently highest, Perry believed that _P. falciparum_ was quite common. In his own language, "I believe that the condition really is that, in Jeypore country, malignant tertian is fairly common". Perry's work covered Jeypore, Koraput and Malkangiri areas. Senior White (1928), carried out his
first studies in Rayagada and Bissam Cuttack areas around 1925, and detected all the three species already recorded by Perry (1914). Prevalence of *P. vivax* (Benign tertian) was highest (46%), followed by *P. falciparum* (Malignant tertian: 35%) and *P. malariae* (quartan: 20%). Viswanathan (1951) during the same period (1928) recorded preponderance of *P. falciparum* in Jeypore area. Later on Senior White (1937a, 1938) confirmed that *P. falciparum* was the predominant parasite in this area based on the morphology of oocysts in mosquito gut.

Reviewing the distribution of human plasmodia in India, Singh et al. (1952) have shown that in Koraput district (Maps 1 and 2 of their paper) *P. vivax* and *P. malariae* (about 70%) predominated in 1930 but in 1950 *P. falciparum* contributed to approximately 50% of the cases. These results may not however be comparable since the actual areas surveyed during 1930 and during 1950 are not mentioned.

3.3. ENTOMOLOGICAL ASPECTS:

The first scientific work relating to malaria vectors dates back to the beginning of the 20th century, when Stephens and Christophers (1902) visited the hills (at Koraput). They discovered *An. jeyporiensis*, Theobald 1903. They attributed the hyperendemic conditions in the locality to the presence of *An. jeyporiensis*, *An. listoni* (presently *An. fluviatilis*, *An. varuna* and *An. minimus*) and *An. maculatus*. However they had not carried out any dissections. Perry
(1914) spent 14 months in the hills (during 1911-12) and carried out detailed studies on the anophelines particularly in the uppermost plateau (Koraput zone). He found 15 species of anophelines in the area of which, he observed sporozoites in An. listoni (presently An. fluviatilis, An. varuna and An. minimus) alone (4/229). He also recorded that An. listoni and An. jeyporiensis were highly man biting (since the indoor resting density of these was higher) compared to An. culicifacies, which was predominantly found in the cattle sheds.

Senior White (1928; 1937a; 1938) carried out extensive entomological studies in different parts of Jeypore hill tracts. In his initial study in Rayagada area of Koraput district (during the construction of Vijayanagaram - Raipur railways) he not only recorded all anopheline species reported by Perry (1914) in Koraput area, but also recorded An. maculatus. He observed that An. funestus complex (same as An. listoni: presently An. fluviatilis, An. varuna and An. minimus) was primarily responsible for perennial transmission of Malaria. He believed that An. culicifacies had no or negligible role if at all any, in malaria transmission (Senior White, 1928).

Following his work in Vijayanagaram - Raipur railways, Senior White carried out extensive entomological studies in different parts of the Jeypore hill tracts (Senior White, 1937a; 1938). He recorded 23 species of anophelines in the area. He detected either gut or gland infection in 6 species of anophelines: An. culicifacies, An.
fluviatilis, An. varuna, An. minimus, An. aconitus and An. jeyporiensis. Of these, both gut and gland infections were highest in An. aconitus. However, he believed that An. funestus complex (vide supra) was primarily responsible for the transmission. Seasonal prevalence of anophelines in a 2 year study showed that An. funestus numbers were high between November and January with a peak in December. An. jeyporiensis though also peaked in December, it prevailed in high numbers from November to March. He also confirmed that a majority of An. funestus were resting in human dwellings, as shown earlier by Perry (1914), but not An. jeyporiensis. This difference is probably due to climatic variations between 3,000 ft. plateau (Perry's area of collection) and 1,000 ft. plateau (Senior White's area of study).

In his second year of investigation he recorded only gut infection from An. culicifacies and both gut and gland infection from An. fluviatilis, An. varuna and An. minimus. While gut infection was highest in An. varuna (11.4%) gland infection was highest in An. minimus (5.7%). He showed the possibility of perennial transmission since gut infection was observed throughout the year. Gland infections in An. fluviatilis was recorded from September to November and in February and March. In An. minimus gland infection was restricted to October and November. He recorded that An. fluviatilis rests mostly outdoors in day time, thereby indicating the possibility of extradomiciliary transmission.
Senior White et al. (1945) also showed that *An. fluviatilis* could transmit malaria at very low densities (less than 1/man hour) in Jeypore hill tracts. Viswanathan (1946a) had calculated that at a density of 0.4 per man hour, this species could carry on effective transmission in western ghat areas.

The series of publications made by Senior White during this period (1928-1945), not only reflects the great vitality, enthusiasm, self confidence and capacities of an individual, but also emphasizes the need for extensive field work in understanding the different situations that existed in Jeypore and adjacent hill tracts.

Entomological studies on malaria transmission in the plains of Orissa have been carried out in detail by several workers (Sarathy, 1932; Senior White, 1937b, Senior White and Adhikari, 1939, Covell and Pritam Singh, 1942; Panigrahi, 1942; Senior White et al., 1943). Venkat Rao (1949b) compared the malaria situation between the hill tracts (inclusive of Koraput district) with the plains in Orissa State. While *An. fluviatilis, An. varuna* and *An. minimus* were the important vectors in the hills, *An. annularis, An. sundalcus* and *An. philippinensis* were the vectors in the plains. He further mentioned that the anthropophilic index of *An. fluviatilis* and *An. minimus* in the hills was as high as 90%. He also believed that *An. fluviatilis* consisted entirely of single vector race in Wynaad area, but in Jeypore hills, it consisted of at
least two races, one of which is the vector and other non-vector, the latter being the more popular. This he had proposed because, in spite of very large number of parasite carriers, only a small percentage of the mosquitoes had infection in this area.

Weeks (1951) recorded 23 anopheline species, confirmed the vector status of An. fluviatilis in Rayagada and Bism Cuttack taluks. Though An. minimus and An. varuna were not found to be infected, he still considered them to be auxiliary vectors in this area. He detected gland infection in a single specimen of An. culicifacies, but none in An. jeyporiensis. The peak density of An. fluviatilis was recorded in October and the species was infective between August and March. An. fluviatilis was found predominantly (97%) to rest indoors in this part of Jeypore hills and a majority (64%) above 2 ft from the floor. The anthropophilic index of this species was 82.6%. In summer, this species preferred to enter human dwellings mostly during early mornings, while in winter, it preferred early evenings.

3.4. CONTROL OF MALARIA IN KORAPUT DISTRICT:

Though Perry (1914) did not study any control measures, he described at length, the possible methods in different zones. He, in fact advocated deforestation and propagation of extensive cultivation as a remedial measure for malaria control.
Senior White had successfully applied 'species sanitation' for malaria control, targeted against *An. funestus* complex (*An. fluviatilis, An. minimus* and *An. varuna*). In Rayagada (Senior White, 1928), and in Jeypore area (Senior White 1937a, 1938) employed environmental management (drainage) and larviciding (application of crude oil) for this purpose and demonstrated that anopheline control was not only feasible but also economical. Control methods advocated by him however could not be sustained in the entire area.

Rao (1930) reviewed the malaria situation in Madras Presidency and mentioned that in August 1913, Major Ross visited Koraput and on his recommendations certain anti-malaria measures by way of constructing well-revetted drains in places of old earthen channels (which were the chief source of vector breeding) were carried out between 1915 and 1920. Based on a report of the Agency officers in 1927, a number of experimental measures were taken up. These included the drainage of swamps with or without silting, cutting up of channels and small streams to render the flow of water smooth and even, growing various kinds of plants such as Clover, Diancha and Redgum for the purpose of decreasing the anopheline breeding. According to Rao (1930), while the latter methods (growing of plants) did not yield much success, the draining of swamps and channels were met with encouraging results. Following which, Sir Malcom Watson (a great malariologist who was a pioneer in species sanitation) visited Koraput (in late 1920s, but no mention of exact time is provided by Rao), on the invitation of...
the 'Tea District Labour Association'. Watson advocated sub-soil drainage of several water channels within a radius of half a mile from residential quarters, instead of tinkering with open drains. This measure is supposed to have produced good results experimentally (Rao, 1930).

Senior White (1936) attempted control of anophelines by the technique of 'Williamson's Herbal Coverage' in Thiruvally, Chattikona (Bisum Cuttack) and Ambadola. He concluded that this measure was not as successful in Jeypore hill region as it was claimed to be in Malaya.

Though Senior White (1928, 1936) had shown that species sanitation of An. fluviatilis was feasible and economical in Jeypore hill area, similar attempts in later period did not produce encouraging results in Jeypore hills (Venkat Rao, 1949a). Viswanathan (1942) obtained some success in controlling An. minimus in Assam by applying species sanitation but not against An. fluviatilis in Bombay province (Viswanathan et al., 1944; Viswanathan, 1946b). Senior White et al. (1945) showed that An. fluviatilis group (An. fluviatilis, An. minimus, An. varuna) spend one daylight period after feeding in the home and then leave the home for some unknown outdoor shelter for the remaining part of the gonotrophic cycle. Both Viswanathan et al. (1944) and Senior White et al. (1945) recommended pyrethrum space spray for fluviatilis control. DDT indoor residual spraying trials in India were initiated in the early forties (Puri, 1947; Viswanathan and Ramachandra
Rao, 1947; 1948). Successful control of *An. fluviatilis* (90% reduction in density) following DDT with a '2 month' spraying interval was demonstrated (Viswanathan and Ramachandra Rao, 1947).

However, in his review of malaria control in India, Venkat Rao (1949a), did not think that indoor residual spraying of DDT was ideal for *fluviatilis* control in hyperendemic hill and foot hills of India. He also ruled out the possible use of larviciding for anopheline control in these areas.

The initial attempts of DDT spraying in Jeypore hill tracts yielded variable results. DDT was introduced in Jeypore hills for malaria control in Bengal-Nagpur Railways (Senior White, 1945). *An. fluviatilis* density, which was 6.4 per 5 manhours in the peak month of October, 1944, prior to DDT spraying was reduced to nil in 1948 catches (Adhikari and Ganguli, 1949). While the above attempt was successful, another DDT spraying over 10 months in other parts of Jeypore hills did not reveal any change in *fluviatilis* density (Senior White and Ghosh, 1946).

Prior to the implementation of the national control programme, a WHO/UNICEF malaria control demonstration project was launched (1949 to 1951) in Bissam Cuttack and Rayagada taluk areas in Rayagada zone. (The WHO team was lead by Dr. Weeks and during the project several prominent malariologists visited the area including Lt. col. Jaswant Singh, the
then Director of Malaria Institute of India; Dr.E.J. Pampana, Chief, malaria section, WHO and Dr.Arnaldo Gabaldon, Chief Malaria Bureau, Venezuela). A single dose of 2 gms. per sq. mt. (200 mg. per sq. ft.) DDT was applied either as an emulsion or as a dispersion formulation. The results showed that both were potent and the residual action was persistent for 10 months. The cost of the spraying was worked out to be Rs. 8/- per capita per year. Preliminary studies were also carried out on the efficacy of Gammaxene (P-520) and Hexidol (Geigy) and it was found that 10 mg./sq. ft. of BHC gave satisfactory vector control for 3 to 4 months, comparable to the effect of 50 mg of DDT/sq.ft.. Higher doses of BHC did not appear to have longer residual effects (Weeks, 1951).

The whole district came under the attack phase of National programme in 1953. Since then, no scientific studies on epidemiological aspects of malaria and its persistence have been undertaken.