this period having been found optimal in many previous drug trials in Tanganyika.

Chloroquine tannate. Chloroquine tannate was administered in tablet form under direct supervision in a dose each day of 19 or 38 mg base, the same regimen being followed as for the hydroxynaphthoate. The results are shown in the table.

Parasite clearance

With both hydroxynaphthoate and tannate at the higher dosage the average densities of parasites in the surviving asexual infections were lower than before treatment. In all surviving infections the predominant parasite was *Plasmodium falciparum*, although two of the lower dosage hydroxynaphthoate films contained sparse *P. vivax*, as mixed infections. The few other cases of *P. malariae* and *vivax* were cleared.

Discussion

For the medication of salt a concentration of at least 0.3% of chloroquine base in the form of easily soluble chloroquine compound, such as the diphosphate or sulfate, is generally recommended. Where the daily intake of salt is less than 10 g (containing 30 mg base chloroquine if prepared in accordance with the recommendation), the proportion of drug must be increased in order to maintain a weekly consumption of at least 200 mg base. This is six times the suppressive dose given to semi-immunes in Tanganyika (75 mg once every two weeks), so that, in East Africa at any rate, there would seem to be an ample margin of effectiveness in the recommended dose.

Chloroquine hydroxynaphthoate, when given in this trial at 38 mg base (approximately the recommended dose of 30 mg base) daily for seven days, cleared asexual parasites in all the 27 patients treated. The cumulative quantity of 266 mg (38 mg × 7 days), effective in every case, is in striking contrast to the failure of massive single doses of up to 450 mg. It thus appears that the suggestion that small daily doses of hydroxynaphthoate might be effective where large single doses have failed is supported by the results of this trial.

Chloroquine tannate, on the contrary, proved less effective when given in small divided doses than in a single large dose. Of course, if the small doses were to be continued daily for two or more weeks (as they would in a medicated salt scheme), it is probable that enough drug would accumulate in the body to become effective.

Identification of *Anopheles balabacensis introlatus* as a Vector of Monkey Malaria in Malaya

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Previous notes have reported that *Anopheles hackeri* and *A. leucosphyrus* are vectors of monkey malaria in Malaya.[a, b] The present note records the demonstration that *Anopheles balabacensis introlatus*, another member of the *A. leucosphyrus* group, is also a vector.

A naturally infected female of *A. balabacensis introlatus* was captured by the use of monkey bait in a net trap in the Ulu Gombak area near Kuala Lumpur. After the glands, which had a moderately heavy infection, had been examined, some of the sporozoites were injected into an uninfected rhesus monkey R302 and some into a human volunteer.

The human volunteer did not develop malaria and two subinoculations of blood to an uninfected rhesus monkey on the 14th and 20th days after injection indicated that subpatent infection was not present.

The rhesus monkey (R302) injected with the sporozoites developed an infection of the *Plasmodium cynomolgi* type on the 11th day after the injection. A very severe infection with a peak parasite density of over 700 000 parasites per mm^3 ensued.

Gametocytes were present in abundance during the infection in monkey R302 and the infection was

[a] Wharton, R. H. & Eyles, D. E. (1961) *Science*, **134**, 279.
[b] Wharton, R. H., Eyles, D. E., Warren, M. & Moorhouse, D. E. (1962) *Science*, **137**, 758.

passed to another rhesus monkey (R127) by the injection of sporozoites from laboratory-reared and -infected *A. maculatus*. This monkey developed an infection with a peak parasite density of 287 000 per mm³ and again gametocytes were produced in large numbers.

From monkeys R302 and R127 two additional monkeys were inoculated by means of infected blood. The first of these two monkeys (R58) had had two previous infections with *P. cynomolgi bastianellii*. The first *bastianellii* infection in R58 had run its acute course and was treated with chloroquine, subsequent to which this monkey received a second *bastianellii* inoculation which produced only a low grade parasitaemia. This infection had also been eliminated by the use of chloroquine about 11 weeks prior to the inoculation with the newly isolated strain. In spite of the fact that this monkey had been demonstrated to possess considerable immunity against *bastianellii*, a severe infection resulted with the new strain with a peak parasite density of 489 000 per mm³.

Although the conclusion is based on only one experiment, it would appear that there is little cross-immunity between the newly isolated strain and *P. cynomolgi bastianellii*, and the new isolation may be typical *P. c. cynomolgi*. This conclusion must be supported by studies of the exoerythrocytic forms which have been shown to differ between the two subspecies.[c, d]

The second monkey (R140), inoculated by means of infected blood, had had a previous infection with *P. coatneyi* and *P. cynomolgi* (subspecies undetermined) which had been eliminated by means of chloroquine. It developed an infection with a peak density of 264 430 parasites per mm³, but the course of the acute infection seemed shortened.

Subsequent to the first finding, two additional naturally infected *A. balabacensis introlatus* were captured on human bait in the same locality. Again the sporozoites were divided and injected into uninfected rhesus monkeys and human volunteers, but none developed malaria infection. Either of two conclusions is possible: (1) that the sporozoites were non-infective, perhaps due to handling; or (2) that the sporozoites represented some other animal malaria. Gibbons, which are known to be infected with malaria in Malaya, are common in the locality.

In previous studies (in preparation for publication) on the susceptibility of Malayan mosquitos to infections with *P. c. bastianellii*, it was found that *A. balabacensis introlatus* from the same locality from which the naturally infected mosquitos came were rather insusceptible to experimental infection. In a total of 17 dissected only one had been found infected, whereas the control *A. maculatus* mosquitos showed a 100% oocyst infection rate, and the oocysts usually matured normally.

Parallel studies were done with the newly isolated strain and it was found that it was quite infective to *A. balabacensis introlatus*. In a total of 7 dissected all were found infected, as compared with 100% of the *A. maculatus* controls. More surprisingly, infections with the new strain developed normally to the sporozoite stage in *A. balabacensis introlatus*, whereas oocysts degenerated and sporozoites frequently failed to mature in *A. maculatus*.

Thus, in addition to the lack of cross-immunity, there appeared to be differences also in the infectivity to Malayan mosquitos.

The human volunteer who had shown no signs of malaria infection through four weeks after the original inoculation was reinjected with sporozoites from experimentally infected *A. maculatus*. No infection resulted, so it was concluded that this individual, at least, was not susceptible to this strain of *P. cynomolgi*.

Even though the human volunteer did not develop malaria, the present finding of *A. balabacensis introlatus* as a monkey malaria vector is of interest in the study of monkey malaria as a possible zoonosis. Systematic trapping in the area from which the infected mosquitos came had shown that *A. balabacensis introlatus* was almost equally attracted to monkeys in net traps in the canopy and to man on the ground. The first of the demonstrated monkey malaria vectors, *A. hackeri*, bites man very rarely, and would probably not be effective in cross-transmission. The second, *A. leucosphyrus*, does attack man and is considered a human malaria vector in some areas, but in Malaya does not attack man as readily as does *A. balabacensis introlatus*.

The present finding is also interesting in that it emphasizes the role of mosquitos of the *A. leucosphyrus* group as vectors of monkey malaria in Asia. All of the demonstrated vectors are of this group, and in Malaya it is suspected that *A. pujutensis* may also be a vector. Whether by coincidence or otherwise, the only areas in India and East Pakistan where monkey malaria is found are also areas in which representatives of this group of mosquitos occur.

[c] Garnham, P. C. C. (1959) *Riv. Parassit.*, **20**, 273.
[d] Eyles, D. E. (1960) *Amer. J. trop. Med. Hyg.*, **9**, 543.