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# Studies on Malaria in Italy during World War II (with special consideration of the region of Frosinone).

By HANS ROTTER.

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During the last war we had the opportunity to observe epidemiological phenomena in respect to Malaria in Italy which are well worth describing. They give an instructive picture of the factors—in a period of disorganization— influencing the development of an infectious disease transmitted by insects.

Up to 1941, *i.e.* before Italy actually became involved in the war, malaria was regressing constantly. This was due to the usual measures employed by a civilized country in peace time, such as: draining of swamps, health service, constant application of the findings of modern research.

In 1941 Italy became a theatre of war. In the following years we observe an increase in the number of infections in the whole of Italy. The increase occurred not only in regions where malaria has always been endemic but also in regions where malaria had been rooted out or never existed. This condition was due to the following factors coming about as a result of the war:

1. Destruction: It created favourable conditions for *Anopheles*, *e.g.* destroyed bridges which caused stagnant waters; destroyed dams which made swamps out of formerly dry regions (Agro Pontino, Region of Maccaresi, Delta of the Po, Province of Venezia); innumerable bomb craters which filled up with water and so became dangerous breeding places for mosquitoes.
2. Impossibility of continued draining in mined areas.
3. Lack of trained personnel and destruction of anti-malarial stations.
4. Increased shortage of drugs such as quinine and synthetic anti-malarials.
5. Overcrowding of malaria infected regions without sufficient medical care and food for people.
6. Spreading of infection to formerly safe regions by soldiers and others carrying gametocytes.
7. Requisition of cattle by military authorities forced the *Anopheles* from cattle to man. This is also true for species which usually would bite cattle only.

Above all the fundamental change in hydro-geological conditions was responsible for modification of the *Anopheles* fauna, thus determining—together with other factors—the degree of malarial endemicity.

In Italy malaria is above all transmitted by *A. labranchiae* and *A. elutus*. The former is found mainly in Sicily and Sardinia, in the centre and the south of the peninsula, the latter along the Venetian-Emilian coast. Where these varieties were favoured by war conditions in their development and spreading malaria grew enormously as in Sicily, Sardinia, in the province of Frosinone, in the Pontine marshes, in the Campagna Romana and in the province of Venice. Where, however, the zoophilic species of *Anopheles* were mainly responsible for the transmission of the disease the raise in infections was not so marked as it depends exclusively upon the settling of gametocyte-carriers. The influence of war is especially marked in the regions of Cassino (Province of Frosinone)

where the swamps caused by war destructions actually enabled *Anopheles maculipennis labranchiae* to develop. The province of Frosinone justifies special consideration because before the war there was no malaria at all whereas in 1944 first infections were approximated to 50,000, *i.e.* over 80% of the inhabitants. Table I shows how the ratio of new infections to recurrency cases had changed in the next year.

TABLE I.

*Malaria cases of different provinces of Latium in 1944 and 1945*  
(Prof. Raffaele, Istituto di Malariologia, Roma).

Province	First		Recurrency		Total of	
	Infections		Cases		Malaria cases	
	1944	1945	1944	1945	1944	1945
Frosinone	50,000	5,475	?	44,528	50,000	50,003
Latina	34,043	2,334	18,144	39,583	52,187	41,917
Roma	8,126	3,442	1,671	12,266	9,797	15,708
Viterbo	323	345	309	555	632	900

The public health service took over the tremendous task of stopping any further spreading of the disease which threatened to become disastrous. The following procedure was employed:

1. Efficient distribution of quinine and other anti-malarials.
2. Annihilation of larvae.
3. Annihilation of the imagines.

In the tackling of these problems the possibility of using DDT proved to be a decisive factor. In those regions where DDT was employed anopheles practically disappeared and as a consequence new malarial infections became extremely scarce and recurrencies diminished considerably. Experience taught that for a constant endemic situation it is sufficient to apply DDT in the houses. However, in order to deal effectively with a situation of diffuse epidemic the fight against mosquitoes must be combined with measures against the larvae.

In the Province of Frosinone the anti-malaria campaign is led by Prof. Raffaele. His first assistant is Dr. Coluzzi who directs the application of DDT in the zone of Cassino. We had the opportunity to observe Coluzzi in his work which may well set an example in this respect. Coluzzi has his headquarters in a central point of the province. For his work he has 40 men at his disposal. Each of these has his own spray apparatus. Early in the morning the men leave headquarters in cars for predetermined places where they split up in groups in order to treat the houses. A proper technique in applying the DDT-solution is indispensable for successful work. Some places are left untreated on purpose so that comparisons can be made later. In the experience of Coluzzi one  $m^2$  requires 1.5 gm. of DDT. The effectiveness remains for about 6 months. Up to now only one treatment yearly is possible. The less threatened areas (hills) are therefore treated first and the flat country just at the beginning of the malaria season, *i.e.* April and May. DDT is used in 5% solution of Kerosine. No special mechanical device for the preparation of the solution is available. The DDT is weighed into empty drums, driven to the Kerosine filling station which is 20 miles away, and mixing is accomplished by the jarring motions of the vehicles on the bad road. When new drums are to be refilled, the old ones

are taken along another time, so travelling 60 miles under considerable shaking not including the way to the place of application. By this procedure complete solution is ensured.

The success of this application of DDT is demonstrated best by Table II.

TABLE II.

*Indices splenici et parasitici from the 3rd zone of the Province of Frosinone*  
(Dr. Coluzzi, Esperia, Italy).

Village	Index Splenicus (%)			Index Parasiticus (%)		
	1946	1947	1948	1946	1947	1948
Cassino	81.2	32.2	3.8	36.8	5.8	—
S. Vittore del Lazio	53.7	24.3	3.7	20.0	11.0	—
S. Elia	34.7	42.7	1.2	22.6	8.0	—
Cervaro	12.6	7.2	4.9	3.0	1.9	—
S. Giorgio a Liri	82.7	16.1	2.4	51.7	4.6	—
S. Apollinare	70.7	10.0	3.1	36.9	5.0	—
Villa S. Lucia	31.8	25.1	7.3	10.0	2.7	—
Pignataro Interamma	65.9	28.3	3.7	50.0	13.9	—
S. Andrea	45.9	16.6	6.7	29.3	2.8	—
Piedimonte S. Germano	70.5	57.0	2.0	24.0	1.0	—
Aquino	90.5	70.6	6.6	45.2	—	—
Pontecorvo	73.3	57.1	7.6	31.6	1.2	—
Esperia	39.0	49.3	14.4	12.0	1.5	—
Castrocielo	68.5	59.0	6.5	22.0	2.8	—
Roccasecca	36.8	51.3	3.2	57.8	—	—
S. Ambrogio s. Garigiano	37.7	16.7	3.8	32.0	1.2	—
Ausonia	54.2	17.5	9.0	22.8	1.6	1.1
Pico	70.0	56.6	2.6	32.0	—	—
Pastena	78.0	51.4	3.7	28.0	—	—
Coreno Ausonia	32.6	13.8	7.6	9.7	9.5	—

All numbers were obtained by regular inspection of school children.

Data given here are chosen from inspection in full malaria-season.

The table shows clearly that the optimistic expectations placed in DDT as a malaria killer even under difficult conditions are well justified. Careful application and constant statistical and medical control must, of course, be presupposed.