WORLD HEALTH ORGANIZATION ORGANISATION MONDIALE DE LA SANTE

ONCHOCERCIASIS CONTROL PROGRAMME
IN THE VOLTA RIVER BASIN AREA

OCP/STAC7.1
OCP/EPI/78.30

ORIGINAL: FRENCH

SCIENTIFIC AND TECHNICAL
ADVISORY COMMITTEE

Seventh meeting

Brazzaville, 21-25 August 1978

ENDEMICITY LEVELS IN ONCHOCERCIASIS

by

A. Prost,[1] J.P. Hervouet,[2] and B. Thylefors[3]

---

(1) Epidemiologist WHO, Onchocerciasis Control Programme, B.P. 549, Ouagadougou.

(2) Geographer, Research Officer, Office de la Recherche Scientifique et Technique Outre-Mer (ORSTOM), Ouagadougou.

(3) Ophthalmologist, WHO, Onchocerciasis Control Programme, B.P. 549, Ouagadougou.

The only recognized definition of onchocerciasis endemicity levels recommended by WHO is that established by the second WHO Expert Committee on Onchocerciasis in 1965 (Technical Report Series No. 335, 1966, p.24):

> "The Committee decided that three levels of endemicity should be established, on the basis of the percentage prevalence of O.volvulus microfilariae in the skins of the population sampled, namely: high endemicity, 67% and more; medium endemicity, 34% - 66%; and low endemicity, 33% or less."

The Preparatory Assistance Mission to the Governments, which was given the task of setting up the OCP Programme, decided to modify these criteria slightly to allow, as the text (Annex V-4, p.3, PAG report, WHO, 1973) says, "for a more flexible assessment", and divided endemicity into four categories: (1) sporadic: 0.1-9.9% prevalence; (2) low or hypoendemic: 10-39.9%; (3) medium or mesoendemic: 40-69.9%; and (4) high or hyperendemic: 70% or more.

The Expert Committee on the Epidemiology of Onchocerciasis that met in 1975 refrained from giving numerical definitions.

Lastly, the Scientific and Technical Advisory Committee (STAC) of the OCP Programme in its 1977 annual report approved the use of the following amended definitions that it considered of more practical value: sporadic, 0-9.9%; hypoendemic, 10-29.9%; mesoendemic, 30-59.9%; hyperendemic, 60% and over.

The very existence of these successive classifications indicates that none of them is capable of giving a true picture of the disease as seen by the epidemiologist, or again that interpretations of the same situation may differ depending on the observer.

A common terminology therefore needs to be defined to allow for rapid assessment, by simple means, of how severely a community is affected by onchocerciasis, both in terms of the prevalence of the disease within the group of people concerned and in terms of the severity of its manifestations in individual cases.

I. Means of measurement and relevant parameters

The effects of onchocerciasis on a stable population may be expressed by means of the following indicators:

1. The prevalence of the disease, i.e. the proportion of persons infected with the parasite. An active case of onchocerciasis is to be defined as one in which microfilariae are shown to be present in the body (skin, or other part such as eye or urine) by one of the methods recognized as being the most sensitive.

Neither examination for adult worms (nodules and cysts) nor the Mazotti test is sufficiently sensitive or reliable to be used to provide other than supplementary data.

Prevalence measures the spread of the disease within the group concerned. As considered here, it covers all individuals in the group, not excluding any age group (0-2 years or 0-5 years). It is expressed as rates adjusted for age with respect to each sex and adjusted for age and sex with respect to the whole sample, by reference to a standard population. In this way the rates obtained for different communities are made comparable by eliminating the effect of different population structures.

2. The mean microfilarial density gives an approximate assessment of the parasite load of the affected person in terms of the number of microfilariae emerging from a skin snip. The microfilaria count varies with the method used (incubation medium, reading time) and the unit chosen (skin snip, milligram or square millimetre of skin).

In this paper the individual parasite load is defined as the arithmetic mean of the number of microfilariae emerging after incubation for 30 minutes in distilled water from two calibrated skin snips taken from each of the iliac crests. The mean microfilarial density of the sample is the geometric mean of the individual parasite loads.

Any other method of determining this parameter may be used. Although the absolute values obtained may be quite different, the difference will be one only of degree and not of kind and the relationship between the microfilarial density and the other variables used in investigating the disease will remain unchanged.

3. The blindness rate, calculated on the census figures for the total population and not on the number of persons examined, in order to eliminate any effect due to absenteeism, is the crudest but also the simplest means of estimating the severity of the ocular sequelae of onchocerciasis. Unless etiological diagnosis is provided by a specialist, the rate will cover all causes of blindness without distinguishing the proportion due to onchocerciasis and should thus be interpreted with caution. The blindness rate is always adjusted for age and sex.

4. Specific eye lesions are investigated from two aspects: the prevalence in the population under investigation of eye lesions resulting from active onchocerciasis and the prevalence of severe and irreversible lesions (sclerozing keratitis, iridocyclitis with formation of synechiae, choroidoretinitis and optic atrophy).

5. Demographic indicators: village size, population density by surface utilized (this "village territory" comprises housing, fields, fallow land and firewood-gathering areas). Increase or decrease in population has no medical significance by itself, but when considered in conjunction with specific indicators of the degree of severity of onchocerciasis, one may explain the other and give an idea of the socioeconomic impact of the disease.

Investigations in progress on the dynamics of surface occupation in the Volta basin strongly indicate that endemic onchocerciasis has worsened since the start of the century. This is thought to be connected with changes in modes of surface occupation.

II. Investigation of the correlations between the variables

Since 1975 OCP teams have accumulated a large amount of data from investigation of 300 villages in the West African savanna. The relationships between the variables we have mentioned can therefore be studied for all or a part of this sample, which is a reasonably homogenous one from the geographical and epidemiological point of view. The conclusions put forward are not claimed to be capable of universal application and should not be transposed to another geomedical context without verification.

(a) Onchocerciasis prevalence and mean microfilarial density

Figure 1 shows the relationship between these two variables. Of the 425 samples (men and women were taken separately), 352 (83%) fell in a fairly narrow well-defined band of regular, though not rectilinear, outline. Not until the prevalence rate was in the region of 40-45% did the mean microfilarial density of the group of positive cases rise above a threshold of 10mf and thereafter rapidly increased.

(b) Prevalence and blindness rate (Figs. 2 and 3)

Blindness is a symptom of which onchocerciasis is one possible cause. The relationship between these two variables was therefore distorted at the outset and we did not investigate it in a number of villages where trachoma was endemic.

Figures 2 and 3 show clearly:

- The male preponderance of the phenomenon: 14% of the villages had no blind men, while 29% had no blind women.

  Blindness affected 10% of the men in 13 villages but 10% of the women in only three villages.

- There was a clear correlation between the two variables even though we were unable to exclude cases of blindness not caused by onchocerciasis. It was found, for both sexes, that in all villages with at least 5% cases of blindness, over 60% of the inhabitants had onchocerciasis. This threshold could even be lowered to 4% cases of blindness. In contrast, in villages with less than 35-40% of inhabitants with onchocerciasis, it was rarely found to be the cause of blindness.

(c) Microfilarial density and blindness rate

The relationship between these two variables was by no means so well defined and the observations were much more widely scattered. The only finding was that in villages with more than 2% cases of blindness, positive cases had, on average, more than 10 microfilariae per skin snip.

(d) Eye lesions (Figs. 4, 5 and 6)

The concentration of microfilariae in the eye was directly proportional to that in the skin, for both sexes. Data from 36 villages (Fig.4) showed that the relationship between the two parameters was nearly linear.

Despite the limited data available for mildly affected villages, ocular onchocerciasis appeared to be practically unknown in communities with less than 40% onchocerciasis cases but increased rapidly thereafter.

In contrast, the prevalence of severe irreversible eye lesions appeared to be much more independent of the level of endemicity (Fig.5). There seemed to be a threshold level at around 50% onchocerciasis cases beyond which the number of individuals with such lesions was likely to rise very rapidly. No village with less than 50% of onchocerciasis cases, even when data were broken down according to sex, had as many as 3% of persons with severe lesions. The percentage of irreversible lesions was found to be dependent to a greater extent on the parasite load (Fig.6), since whenever the mean microfilarial density rose above 10mf a large proportion of severe lesions were found in the sample, particularly with regard to men, who showed more severe lesions than women with the same parasite load.

(e) Demographic indicators

As part of a study of the dynamics of surface occupation in the valleys of the White Volta and the Red Volta, we attempted to assess the impact of onchocerciasis as an obstacle to development and as a factor of decline.

Since it was impossible to make detailed surveys, fairly crude indicators were employed, such as administrative censuses, blindness rates taken from administrative lists used for tax exemption purposes, proportion of persons with nodules as diagnosed by teams in the major endemic disease control service.

A survey of 20 Bissa villages (Fig.7) confirmed that the number of blind persons increased with the proportion of persons with nodules. It showed, however, that all villages with over 5% blind persons had a population growth rate under 1% a year. Only one village had as low a growth rate without reaching as high a blindness rate, but this was probably due to a combination of circumstances as it had over 20% of persons with nodules. Furthermore, all except one of the villages with this level of onchocercal infection were growing very little if at all. Since average population growth in the Bissa area was 2.8% a year during the period of observation the occurrence of a rate below 1% indicated population loss by emigration and such villages could be considered to be in decline. A blindness rate of 4 to 5% in any community therefore seems to be a threshold of intolerability leading to depopulation.

Between the White Volta and the Red Volta, first-line villages with a blindness rate of over 5% were almost all small ones with less than 500 inhabitants (Fig.8). Nevertheless, some villages, like village 49, with nearly 1000 inhabitants had a blindness rate of over 5% while some with less than 150 inhabitants had a low blindness rate (village 71). However, the population density per square kilometre utilized was less than 25 in the first case and over 100 in the second. This would seem to indicate that it was not the size of the village that affected the transmission of onchocerciasis but the population density in terms of the surface utilized: village 53 had the same population as village 71, but its territory supported less than 25 inhabitants/km^2 and it had a blindness rate of 13%. Villages 61 and 64, for instance, had not many inhabitants but had population densities above 50 inhabitants/km^2 and a blindness rate of less than 4%.

Figure 9 combines the above data and shows that no territory with a population density of over 50 inhabitants/km^2 had a blindness rate of over 5% and that most villages in this group showed definite population growth (over 1.8% per year). Those villages with the highest blindness rates were in absolute decline (annual growth less than 0). The general rule seems to be, except in special cases, that first-line villages with less than 35 inhabitants/km^2 have a growth rate below 1.8% per year and a blindness rate of over 5%. This does not mean that one should jump to the conclusion that it is the high level of endemicity that is responsible for the depopulation which may run the risk of mistaking the cause for the effect.

We have no scientific data from which to assess the consequence of high endemicity on fertility, natality and mortality. There is therefore no way of affirming or denying whether onchocerciasis is directly responsible for low population growth in the communities concerned. Furthermore, the population shrinkage caused by emigration from villages affected by onchocerciasis raises their endemicity level since it is generally the young people, and hence the lightly infected cases, who go away.

Because the socioeconomic patterns of the population groups concerned demand close and constant contacts, the threshold value of 50 inhabitants/km^2 may not be the "intolerability" threshold of onchocerciasis. High blindness rates in villages with territories supporting between 35 and 50 inhabitants/km^2 are largely due to the departure of young people for large centres and a money economy. Since there are no longer any means of retaliation against individuals within the society, they can leave for places they consider to be better. On the other hand, at under 35 inhabitants/km^2, the cause of high blindness rates is no longer emigration but a deteriorating epidemiological situation, in which the very young are implicated.

It can therefore be said that any community settling in an area with a high level of transmission of onchocerciasis and adopting a mode of surface occupation that involves population densities of less than 35 inhabitants/km^2 is doomed in the long run (no lasting settlements of this kind have been found as far back as records go).

Attainment of a threshold blindness rate of 5% in a community is always accompanied by the realization that the situation is intolerable, which aggravates or triggers off the process of desertion.

III. Comments

There is a level of severity of the disease, corresponding to what entomologists have called the desertion level and we prefer to call the intolerability level, at which the survival of the community as a group is at stake. This seems to occur whenever the blineness rate rises above 4 to 5% of the total population. The population then starts to decline, at least relatively, as a result of a combination of health factors and social factors and the surface occupation density tends to fall below 50 inhabitants/km^2 until it reaches a critical threshold value of 35 inhabitants/km^2 at which first-line villages are doing no more than living on borrowed time. All such villages also have:

- over 60% of onchocerciasis (in practice 58-60%);
- over 20% of persons with ocular onchocerciasis;
- over 10% of persons with severe ocular complications;
- mean microfilarial density of over 10-15mf.

Not all communities with over 58 to 60% cases of onchocerciasis are in this situation and they may have different values for the other parameters. However, it seems reasonable to consider this rate as a threshold beyond which there is a major risk of the situation becoming intolerable. The existence of this risk is what we propose as a basis for the definition of hyperendemicity.

On the other hand, when infection is below a certain level, the disease is socially inapparent. A number of individuals may be found with nodules, or a few skin lesions, and a high microfilarial load. In such communities, however:

- onchocerciasis is not a causative factor of blindness, or is an unimportant one, and the blindness rate is generally less than 1% (except in places where there is another major endemic disease, such as trachoma);

- less than 10% of the population have ocular onchocerciasis and the number of irreversible ocular lesions is in single figures (always less than 2.5% of the population);

- mean microfilarial density for all positive cases is less than 10 (according to our method of calculation).

This level of perfect tolerance exists in almost all villages in which we found less than 40% of cases. Above this threshold level of 40%, however, more severe symptoms soon begin to appear, particularly in those villages departing earlier from the norm, that is from the usual rate at which the situation develops in most communities. The mean microfilarial density increases and may quickly rise above 20mf, blindness rates sometimes reach 3 or even 4%, the prevalence of ocular onchocerciasis, negligible until then, becomes a significant factor, although the proportion of irreversible lesions remains low. Thus, we prefer to propose to define hypoendemicity, the tolerable level of the disease, by the existence of less than 35% of cases in a community.

Between these two limits, less than 35% and over 60%, every type of situation may be found. Collective resistance factors (population density per village territory), individual susceptibility factors, and differences in exposure to risk according to sex, occupational or ethnic category, social division of labour or the mode of working the village territory, mean that no general law can be formulated to describe what is usually called mesoendemicity. The definition of mesoendemicity is thus purely a negative one: a situation is mesoendemic when the disease ceases to be socially inapparent but has not yet reached a level that is intolerable for the group affected.

It does not seem to be necessary to retain the concept of "sporadic prevalence". A sporadic disease is defined in epidemiology as one in which cases occur in an unrelated manner. As far as onchocerciasis is concerned, this would apply only to peripheral villages on the edge of the disease zone or outside it. The only cases found in such villages are imported cases in persons who have come in at some time from a known endemic area (up to 10-15% of men in some villages in northern Upper Volta or Niger); or "indigenous" cases resulting perhaps from the accidental migration of infected blackfly. Sporadic cases may occur in varying numbers, but there is no level of sporadic endemicity.

Conclusion

The prevalence of onchocerciasis in a population, as defined by standardized rates for microfilariae carriers, is the simplest parameter for a survey team to measure rapidly in the field and does not require sophisticated technology. The correlations we have investigated show that the severity of the disease is always related to the degree of its spread in the community. The prevalence rate is therefore a suitable means for defining levels of endemicity in onchocerciasis.

It follows from the above investigation that:

(a) when onchocerciasis affects 60% or more of the people in a community the situation is intolerable or is likely to become so in the short- or long-term. Such communities are in an unstable state. This is hyperendemicity;

(b) when onchocerciasis affects less than 35% of persons, the effects of the disease are limited and it is socially inapparent. This is hypo-endemicity;

(c) where there are between 35% and 60% of cases, the degree of severity varies both from one group to another and from one person in a group to another. This is mesoendemicity.

These definitions, based on findings in the West African savanna zone, are not universally applicable. We feel, however, that onchocerciasis is found in this region in its most severe form and there is little chance that studies made in other ecosystems will lower the two threshold values we have defined.

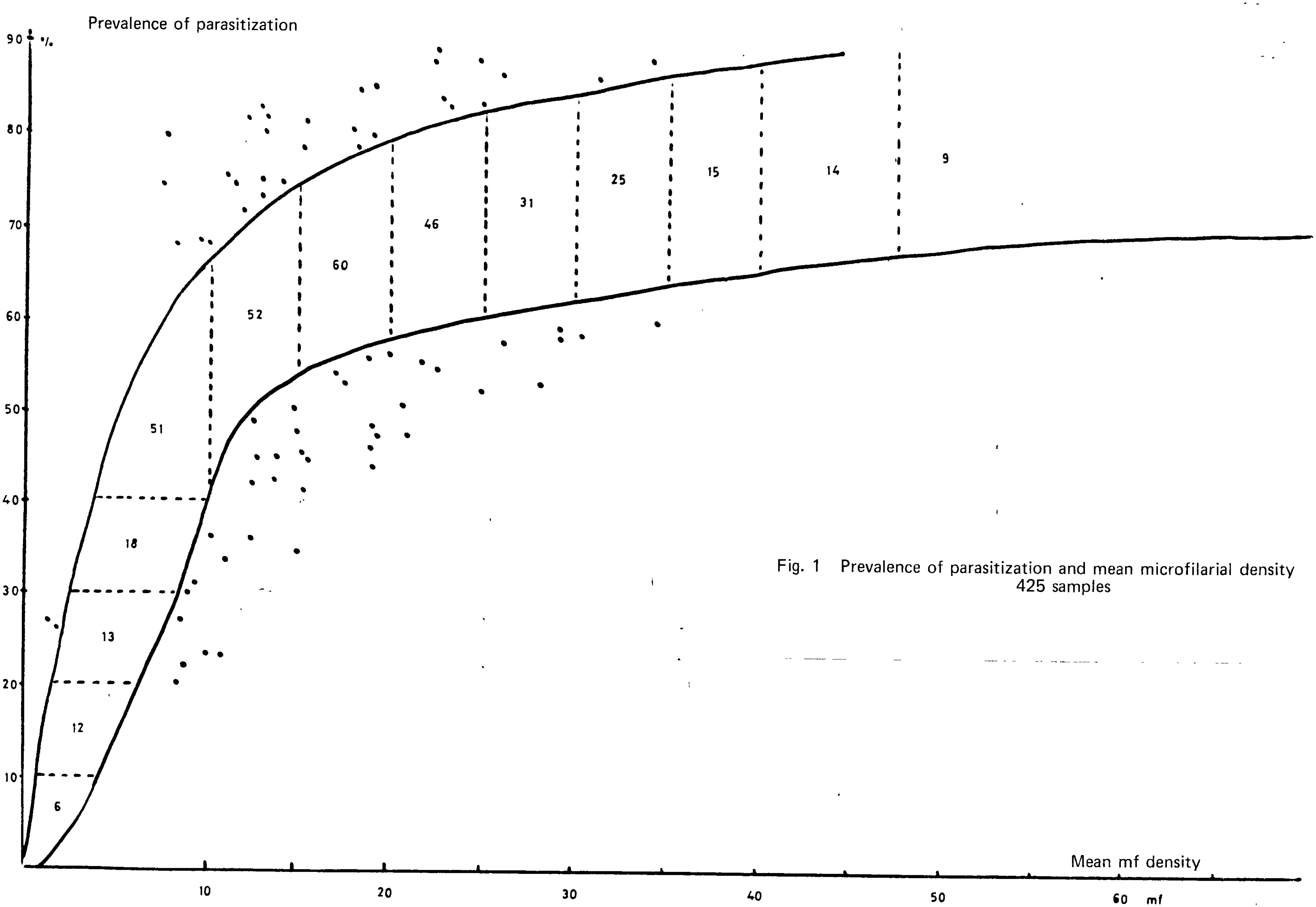


Fig. 1 Prevalence of parasitization and mean microfilarial density
425 samples

WHO 78573

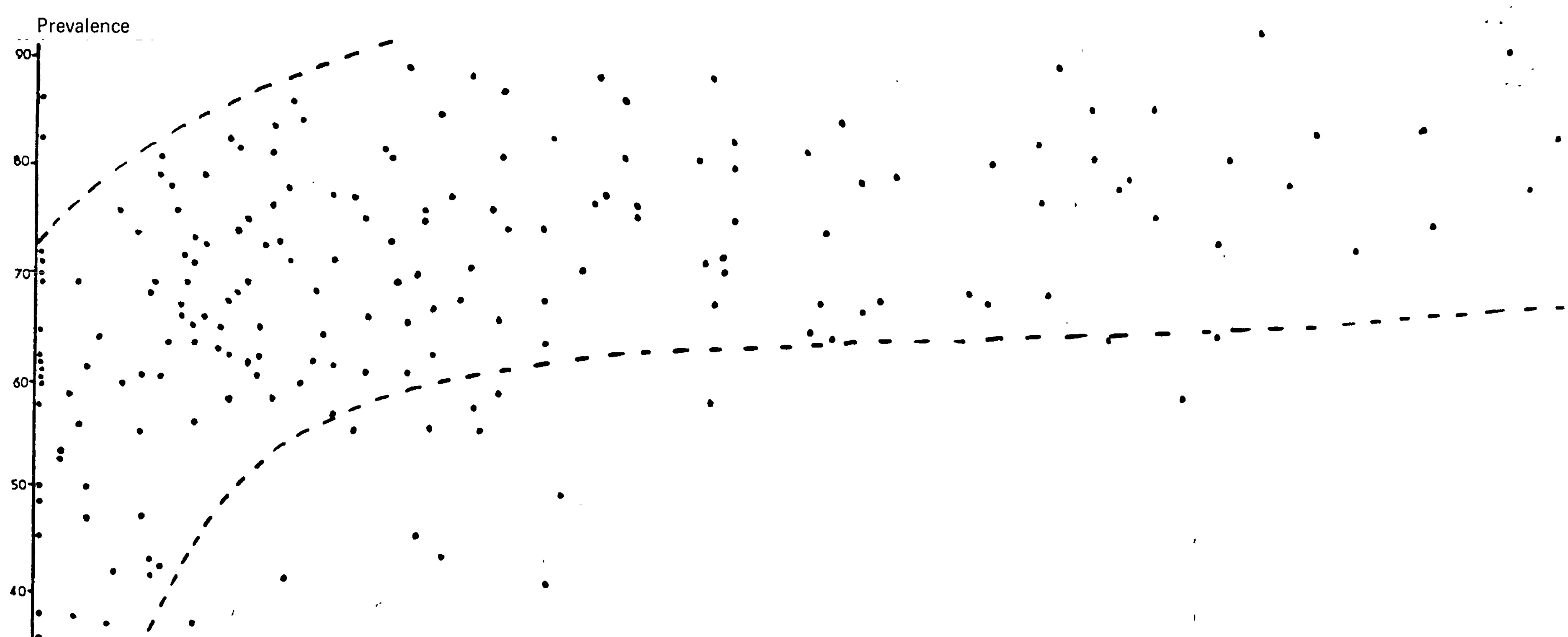


Fig. 2 Blindness rate as a function of prevalence
♂ in 210 villages

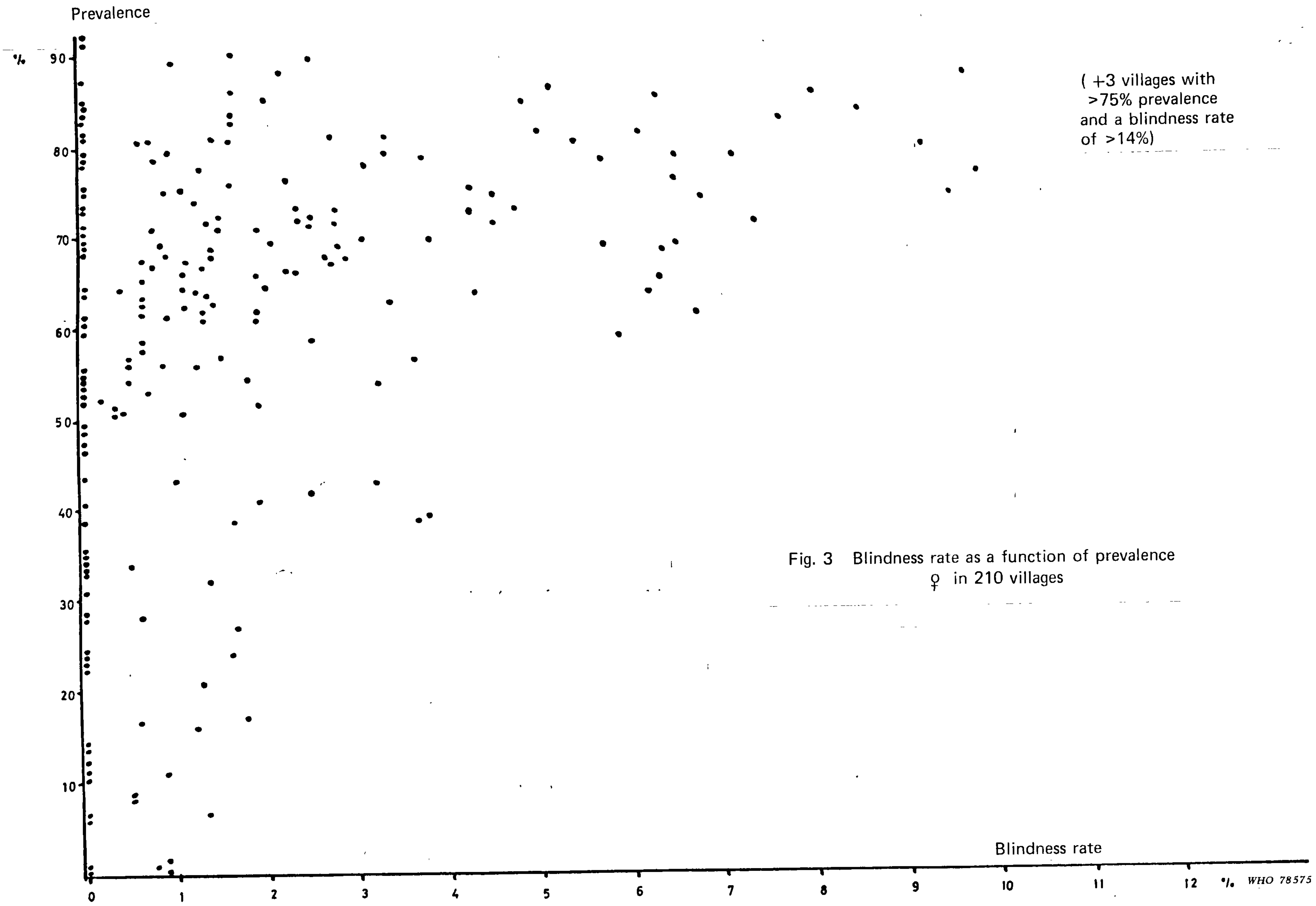


Fig. 3 Blindness rate as a function of prevalence
♀ in 210 villages

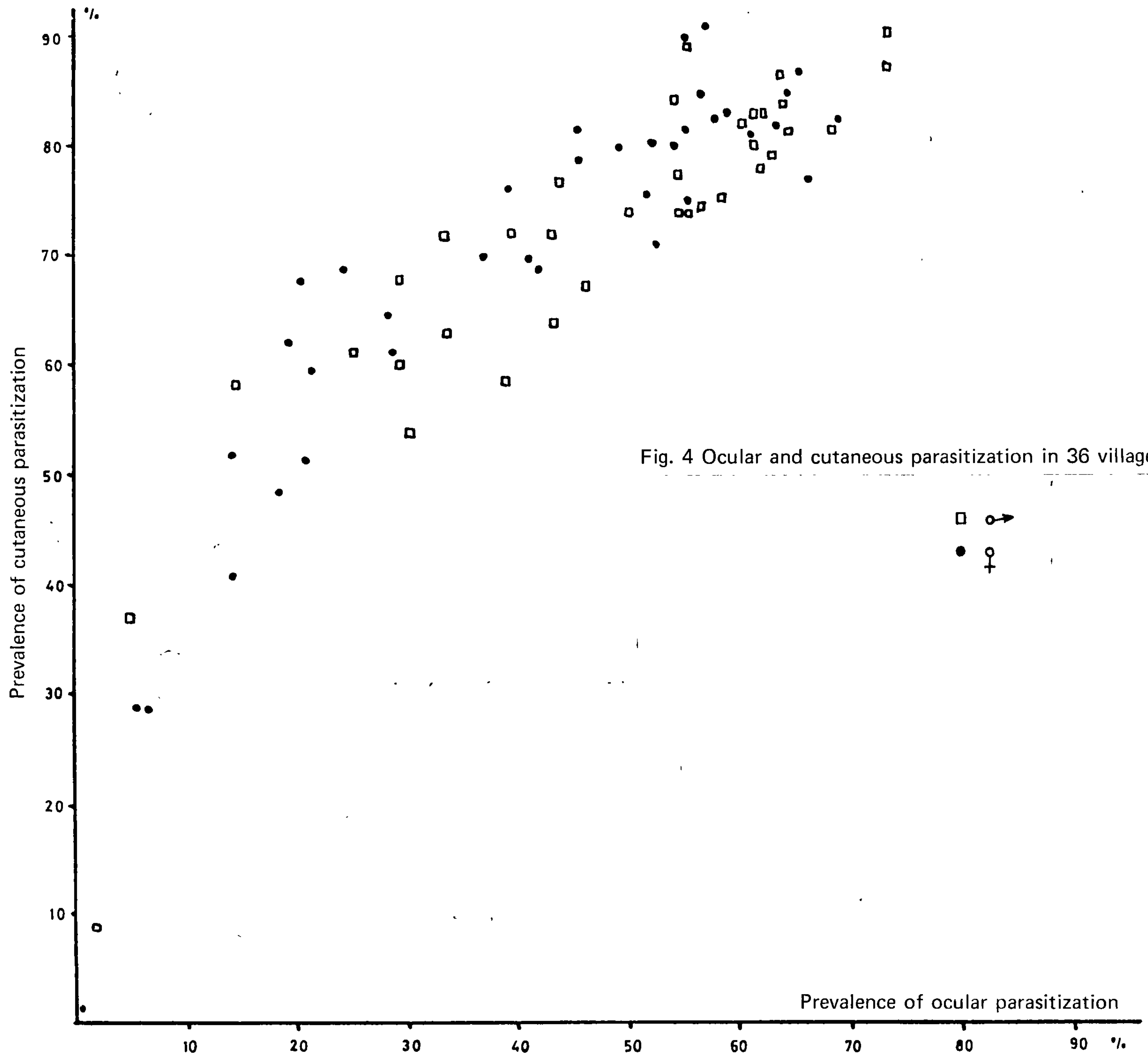


Fig. 4 Ocular and cutaneous parasitization in 36 villages

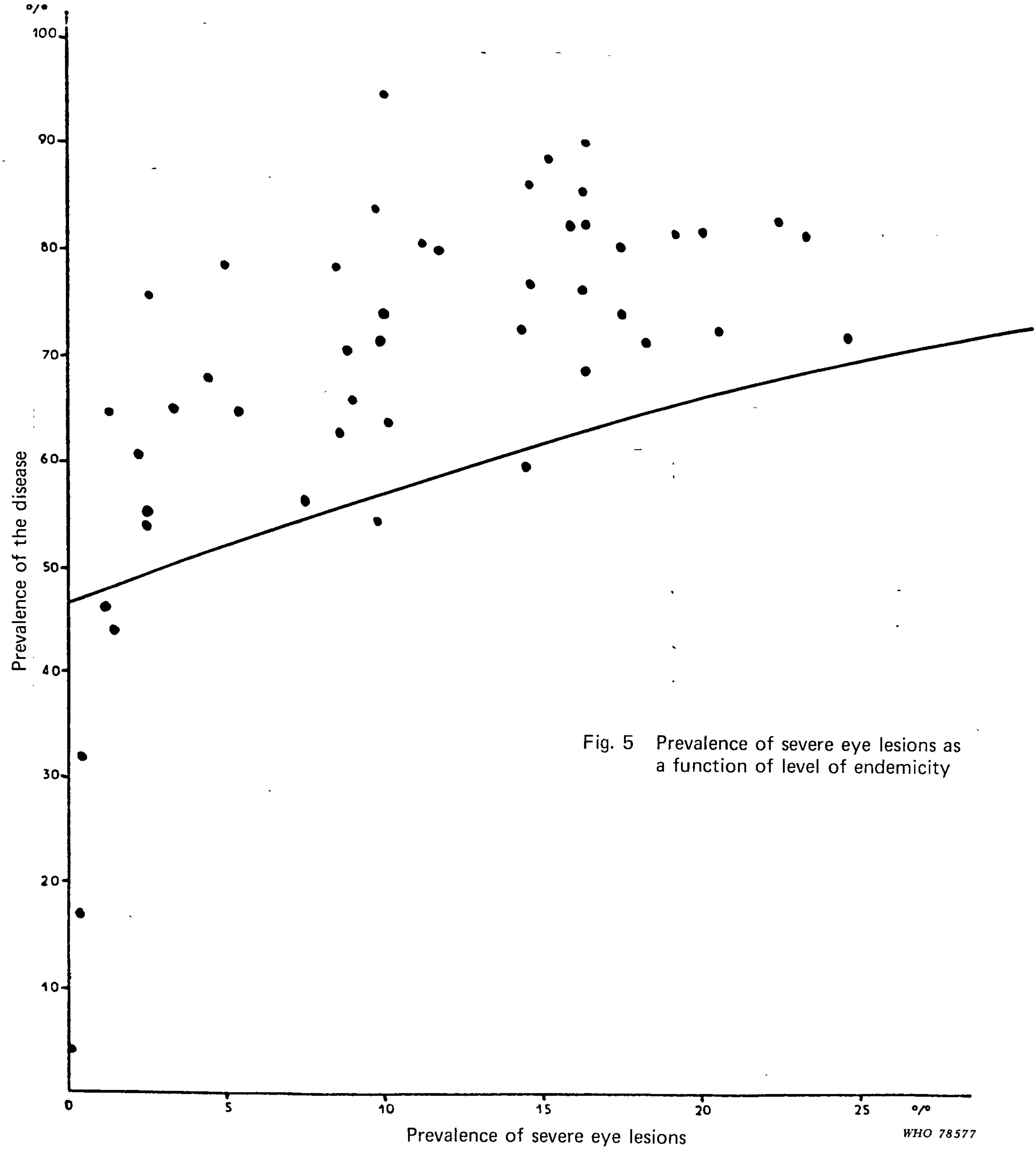


Fig. 5 Prevalence of severe eye lesions as a function of level of endemicity

Fig. 6 Increase in the proportion of irreversible eye lesions as a function of individual parasite load.
(Mean data for 30 villages: sexes considered separately)

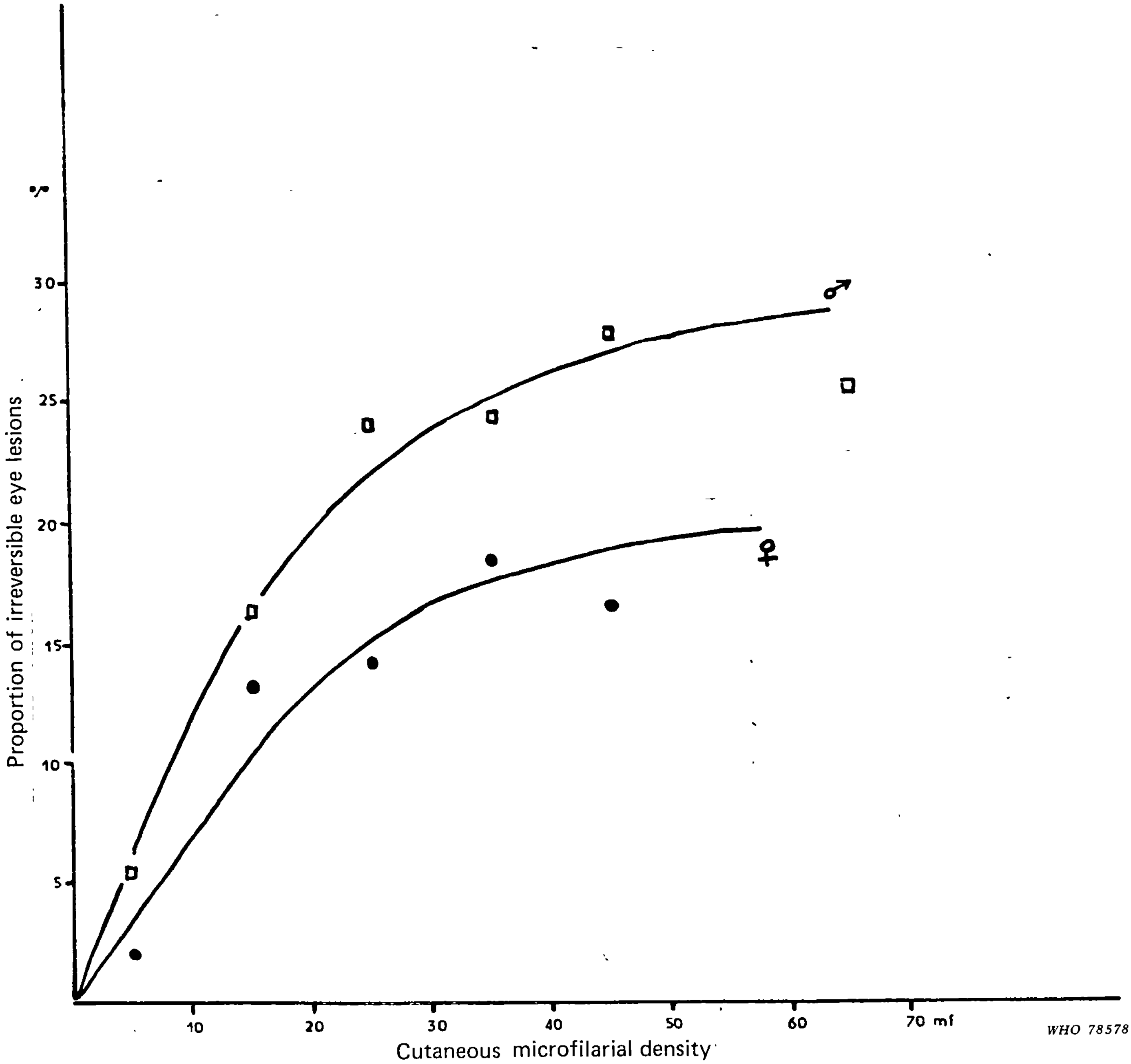
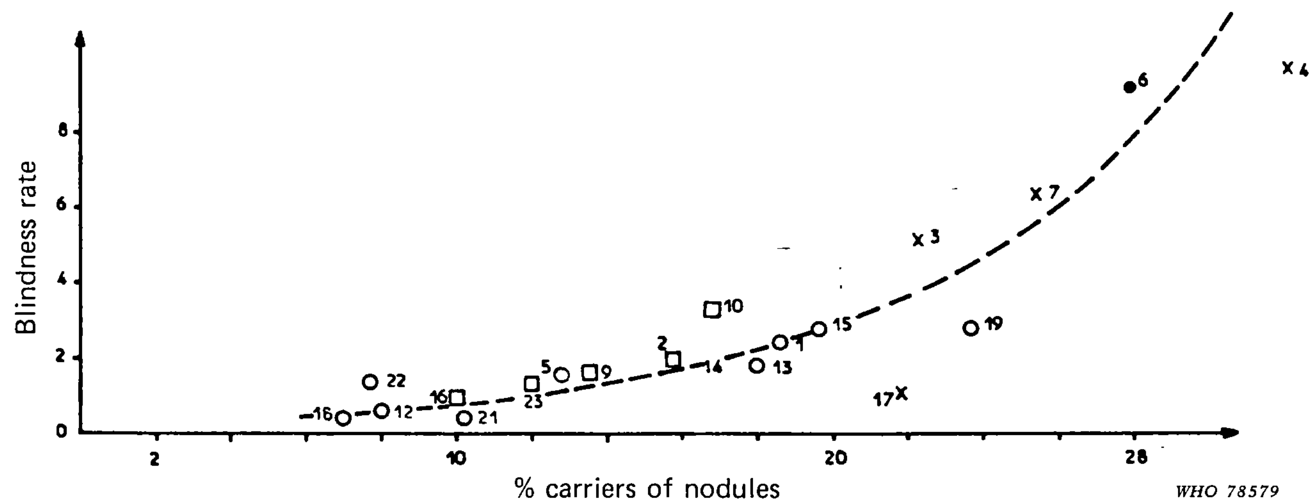


Fig. 7 Blindness, presence of nodules and population growth



Population growth rates during the previous 10 years

- □ $k \geq 3$
- o $1 \leq k < 3$
- x $0 \leq k < 1$
- • $k < 0$

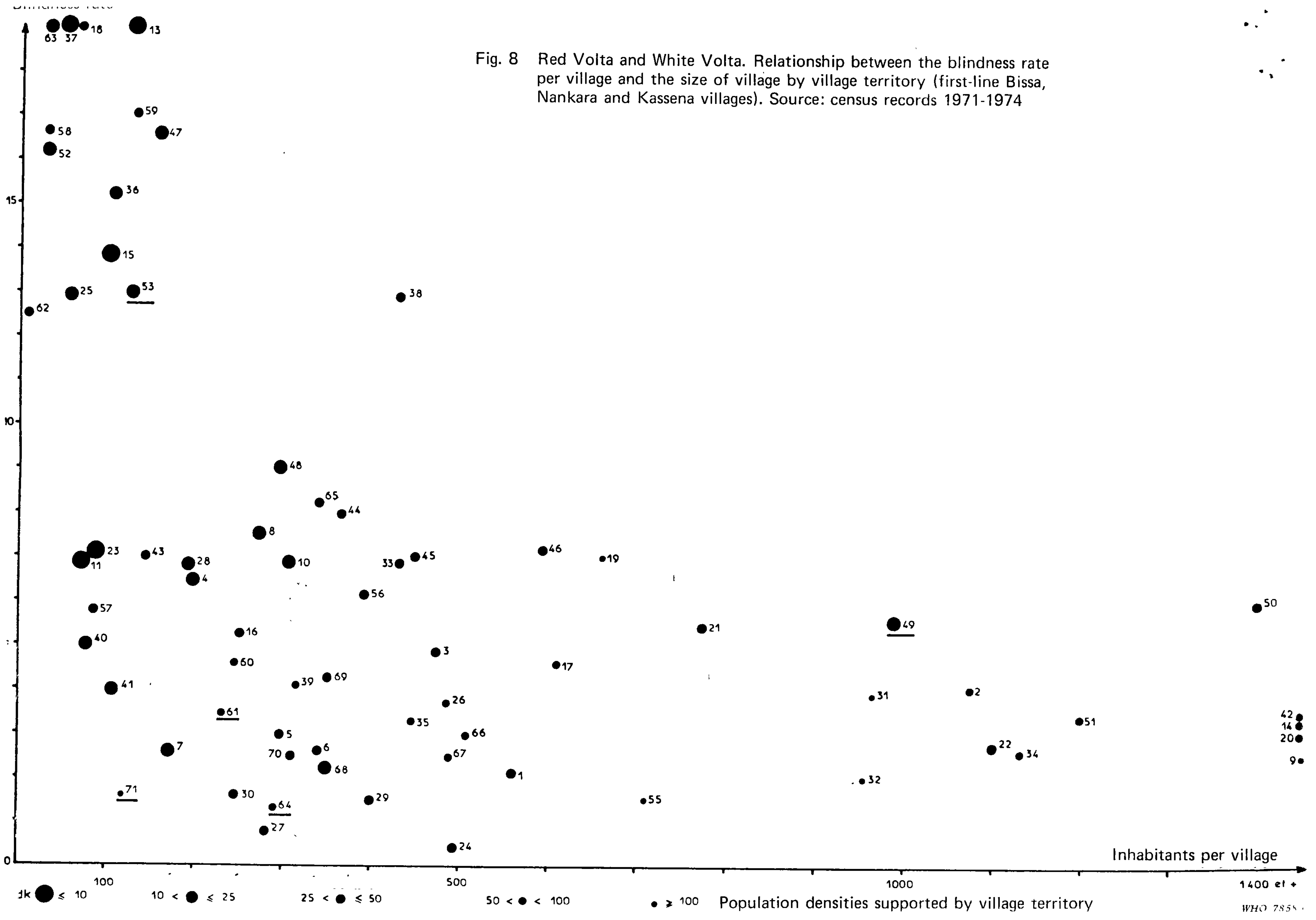


Fig. 8 Red Volta and White Volta. Relationship between the blindness rate per village and the size of village by village territory (first-line Bissa, Nankara and Kassena villages). Source: census records 1971-1974

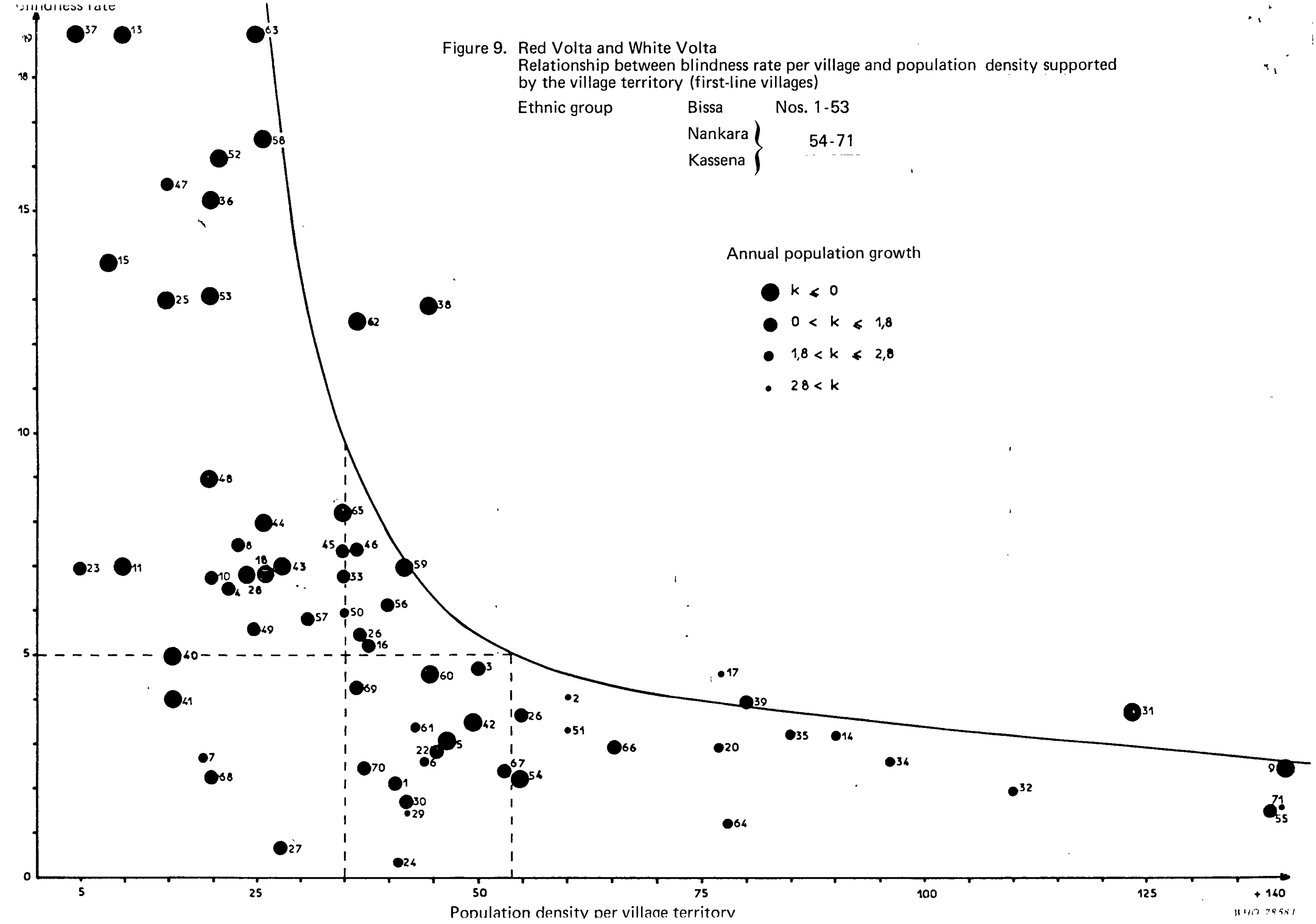


Figure 9. Red Volta and White Volta
Relationship between blindness rate per village and population density supported by the village territory (first-line villages)

Ethnic group: Bissa — Nos. 1-53; Nankara, Kassena — 54-71