Description of Fasciolopsis buski Infections in Thailand by Use of a Catalytic Model

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OBJECTIVE: Since many parasitic diseases exist at steady state levels of prevalence, it is possible to learn a great deal about the pattern of acquisition and loss of infection by analysis of age-specific prevalence data. By substituting age for time, attempts to fit exponential rate functions to the data are feasible. The application of these techniques has been described by Muench.[1] Previous Fasciolopsis buski surveys[2, 3, 4] have suggested that the prevalence typically reaches a peak in the 10–15 year age group and drops with older age groups. The purpose of the present study is to apply the new analytic approach to F. buski prevalence data in order to derive statistics describing the transmission of the parasite in quantitative terms.

DESCRIPTION: Study Populations: Pak Hai, Ayuthaya Province. The study area consisted of a small village along a tributary of the Noi River a few kilometers from the town of Pak Hai. No sanitary facilities are available in the village and the people usually defecate into the standing water beneath the houses (see 1969 Annual Report on Fasciolopsis buski). There is little evidence that the way of life of the people in the village has changed significantly during recent history, so that fundamental assumption of this application of catalytic models, the interchangeability of age and time, seems justified.

Kho Kho Tao, Suphanburi Province. The village of Kho Kho Tao, unlike Pak Hai, is situated at the edge of the basin in Central Thailand where the annual flood waters inundate the land. Approximately one-third of the village is situated over the water and the remainder on dry ground. No sanitary facilities are available, but the chance of parasite eggs reaching the water is considerably less than at Pak Hai, where the ground is almost completely covered by water for several months each year.

METHODS: A house-to-house survey was carried out in Pak Hai, with all houses along a 1 km stretch of the river being visited. Stool cups were distributed to all members of each family. Name, sex and age were recorded, and usually, whether or not the youngest members had begun to eat uncooked green vegetables. Stools were collected on successive days and returned to the laboratory for processing (see 1969 Annual Report on F. buski). The response rate was approximately 65%. All stools were concentrated by the formalin-ether technique and examined microscopically for F. buski eggs by three examiners at Pak Hai, and two at Kho Kho Tao.

The Kho Kho Tao data were not originally intended to be subjected to detailed age-prevalence analysis, so that the sampling was not uniform. Approximately 30% of the sample was composed of 5–15 year old children surveyed in the school. The remainder was obtained by house-to-house surveying as at Pak Hai. We place less importance on conclusions reached from these data.

The two stage catalytic model described by Muench[1] assumes that newly exposed people become infected at rate a, become negative at rate b, and remain negative. The rate of change in prevalence is

$$\frac{dP}{dt} = ae^{-at} - bP$$

where e^{-at} is the proportion of people at time (or age) t that have never been infected, and P the proportion at that age actually positive. The solution is

$$P = \frac{a}{a-b}(e^{-bt} - e^{-at}).$$

The rates a and b can be found to roughly two decimal places by calculating two moments from the data and entering them on a nomogram supplied by Muench. The solution can be tested for goodness of fit with the X^2 statistic with k–2 degrees of freedom, where k is the number of age groups, reduced by the number of constants (two in this case) derived from the data.

The survey data were divided into age groups as uniform in width as possible, consistent with each having approximately 50 people. The younger people were divided into 5 and 2 year groups because they were more numerous and in order to increase the resolution of this critical region of the prevalence curve.

One additional assumption was made prior to analysis; risk of infection was taken as beginning at two years of age and the curve was fitted so that $t = 0$ at age two. This decision was made on the basis of information obtained during the interviews which suggested that few babies under two years of age had begun eating vegetables.

PROGRESS: Pak Hai. An excellent fit to the data is obtained with the two stage catalytic curve, shown in Figure 1. In the test for fit, $X^2 = 7.70$, DF = 9, $.75 > p > .50$. The exponential rates, $a = 0.23$ and $b = 0.024$, can be converted into finite rates from:

$$a_{(finite)} = 1 - e^{-a} = .205 \text{ per year}$$

$$b_{(finite)} = 1 - e^{-b} = .023 \text{ per year}$$

The peak prevalence is predicted to be at age 13 by the equation. If everyone in the population is at risk, virtually everyone will have been infected by 20 years of age.

Kho Kho Tao. The prevalence over age 30 is significantly lower than the prevalence under age 30 (X^2 with 1 DF, $p < .005$), indicating that a survey that rises to a horizontal asymptote is not appropriate for these data. The fitted two–stage model is shown in Figure 2; the hypothesis that the data conform satisfactorily is strongly rejected (.005 p .001). The data which deviates most markedly from the model was obtained in the 2–8 year age groups. The actual rate of acquisition seems to be about double the 3.2% per year required to produce the prevalence observed for the older age groups, if the model provides an adequate description of transmission.

Mere reversibility of stool positivity and negativity is not sufficient to produce a decline in prevalence with age and, therefore, cannot be considered in interpretation of the results. At least three possible types of explanations for decline in prevalence with age can be considered; (a) nonreversible loss of parasites due to immunity; (b) unsuitability of older hosts for parasite survival to maturity (excluding immune mechanisms); and (c) decreasing risk of ingestion of metacercariae with increasing host age. Information gathered from personal interviews and questionnaires, which were distributed to many of the villagers, suggest that the ingestion of infection–carrying vegetables was not related to age in adults, so that assumption (c) alone cannot likely explain so marked a decline in prevalence as seen in Pak Hai. Our data do not permit discrimination between assumptions (a) and (b); further, we do not, at present, have any particular *a priori* model for non–immune host unsuitability. The first explanation conforms exactly to the two–stage model and is obviously an attractive one, but since there is little evidence for immunity to fasciolopsiasis, we suggest both explanations (a) and (b) as being possiple. Preliminary findings (see 1970 Annual Report on Immunologic Response of *F. buski*) indicate that there is a serologic response in man to infections with *F. buski*, suggesting the possibility that acquired immunity is also operative.

We cannot provide a definite explanation for the poorer fit of the Kho Kho Tao data, though an increase in the infection rate during the past 8–10 years is one possibility.

Additional information about the physiology of the host–parasite interaction and quantitative information about diet are necessary before generality of applicability of the two stage model for *F. buski* infections can be claimed.

Analysis of the age–specific prevalence of several of the parasites common in northeastern Thailand is now underway.

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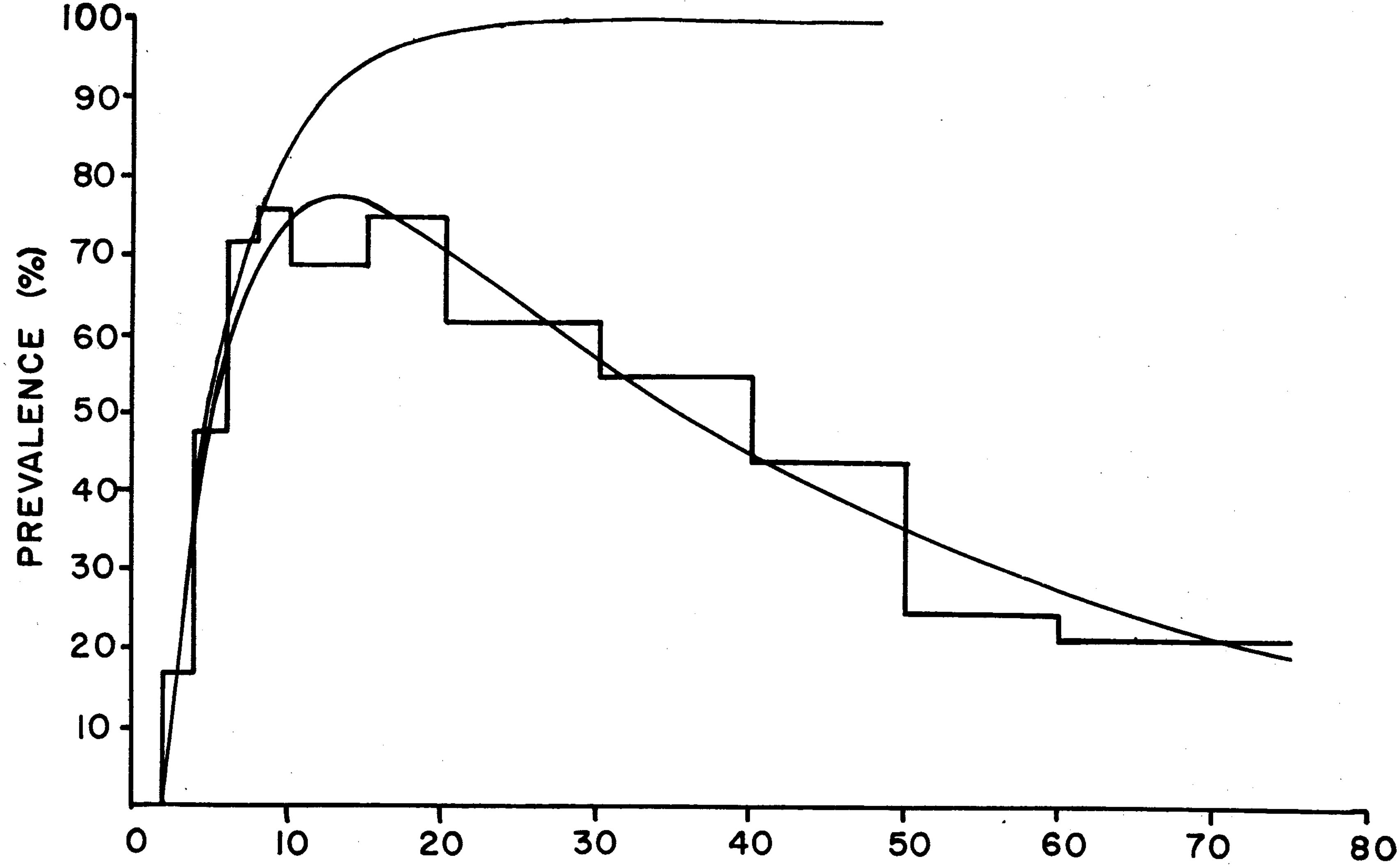

Fig. 1 Age specific prevalence of F. buski infections at Pak Hai. Data indicated by horizontal lines; the fitted curve by the lower smooth line. The upper curve represants the acquistion of infection predicted by $P = \frac{a}{a-b}(e^{-bt} - e^{-at})$ where b = 0.

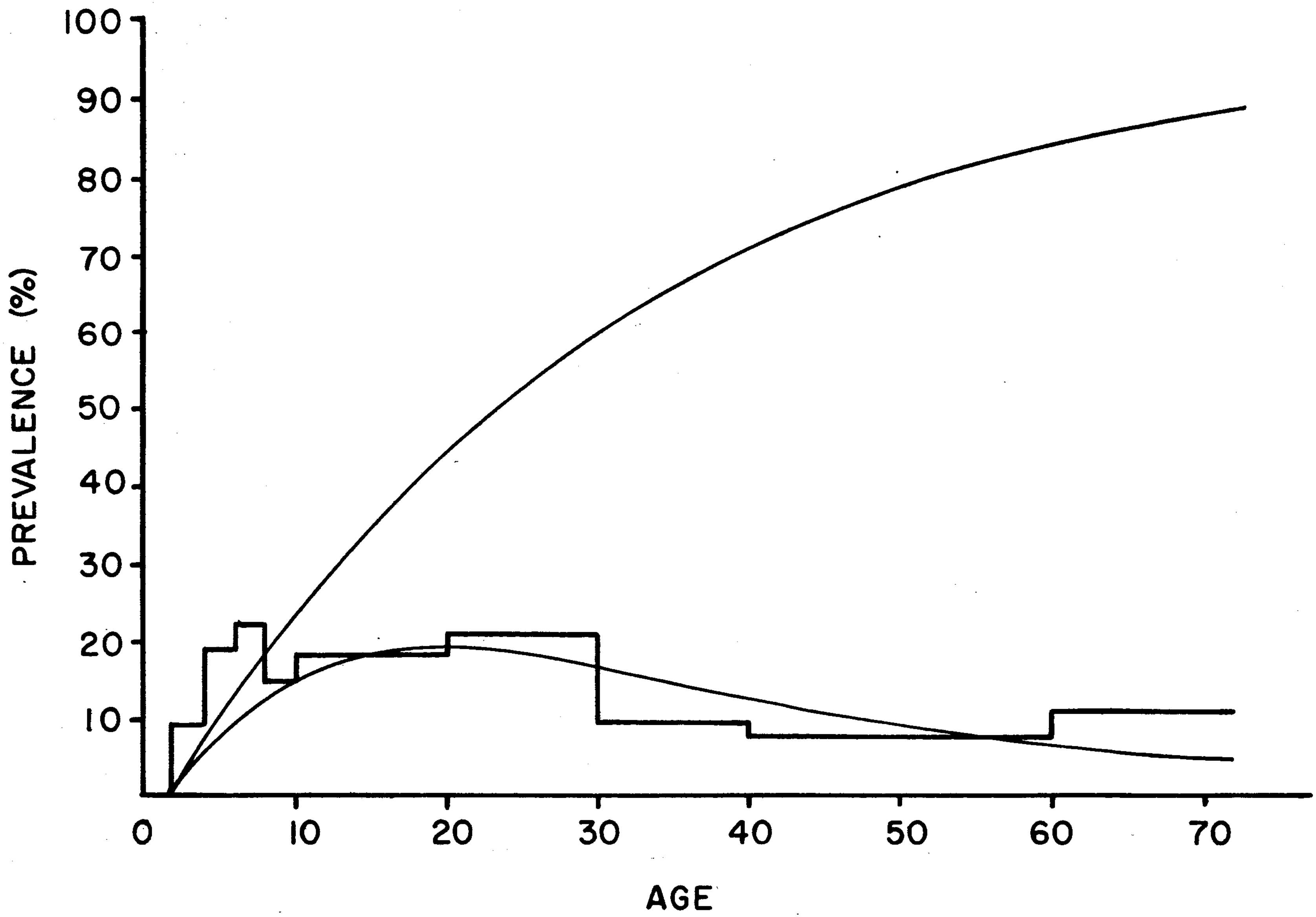

Fig. 2 Age specific prevalence of _F. buski_ infections at Kho Kho Tao. The various parts of the figure have meanings as described for Fig. 1.