

## DISCUSSION

The epidemic of any bacterial enteric disease is closely linked with water. Gaffky and his colleagues demonstrated the presence of Vibrio cholerae in a tank in Calcutta which served as source of water supply (23). At that time the survival and multiplication of Vibrio cholerae in water was not known. There were many investigators who tried to answer this problem. The result that most of workers agreed upon was the Vibrio cholerae can survive in chlorinated water a very short period (42, 43). In unchlorinated water cholera vibrios can survive for much longer periods (42, 43). The survival time observed in the cases of the raw water was shorter than that for filtered water or sterilized water (31, 37). This fact was explained by some investigators in India as due to the heavy contamination of raw water by other organisms (28, 31). The results of this investigation in Chiengmai parallels those shown for the water of India in that contaminated water, presumably because of biologic competition appears to be unsuitable for extending survival of the enteropathogens.

Table II shows that Shigella flexneri could not be found other than initially, while Salmonella typhosa and Vibrio cholerae could persist in unpolluted water as long as ten days and in heavily polluted water a few days. This illustrates the same problem faced by other workers (18, 24) who could not isolate shigellae from river water and irrigation water while salmonellae were frequently recovered.

From this study the Selenite F broth seemed to do very little

to enrich the growth of Shigella. Table IV, however shows that as few as 84 organisms per milliliter could be detected; but survival was but a few hours except when the inoculum exceeded  $10^5$  organisms per milliliter.

Survival of cholera vibrios in water may depend upon temperature, pH, salt content, organic matter present and degree of bacterial contamination (37, 43, 44). But from this study there seemed to be no relationship between survival and calcium and iron content. Only the degree of bacterial contamination appeared to play a major role.

While pH is undoubtedly influential on growth as well as survival as mentioned by some workers (11, 21, 44). The studies in Chiengmai using the water jars showed slight variation in pH (Table V) which probably had little effect in this situation.

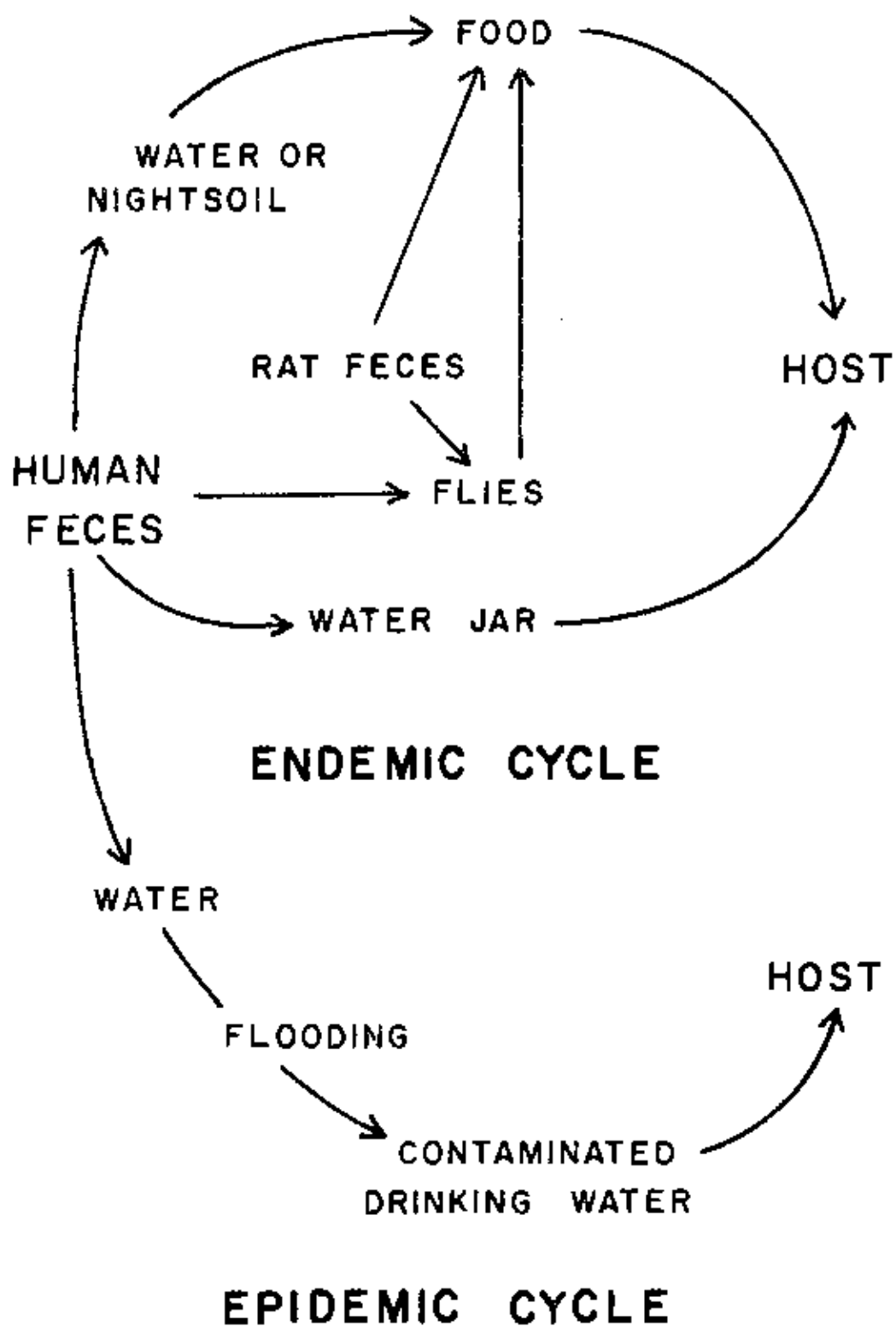
Since Vibrio cholerae can live in water longer than Salmonella typhosa and Shigella flexneri, we need to have further study on the difference in their nutritional pattern. This would help to explain the reason why the later two organisms could not live very long in the water.

Direct association of the 1963 to 1964 cholera epidemic in Chiengmai with the floods in late October and early November was observed. When the flood stage occurred the water easily reached sewage and excreta. Some of this excreta probably contained cholera vibrios as Van de Linde in Hong Kong, 1961 to 1963 (54) showed by the result of nightsoil sampling in which the presence of a large number of symptomless excretors of cholera vibrios were

found in the population. Thus the organism was present in the city, and the flood water picked up the organisms and transported them to the leaky wells of drinking water in various parts of the city. Not only was a water-borne epidemic spread by flood, but also the organisms were able to live longer when the surface water was diluted with rain. By this factor the epidemic lasted longer and thus reached more people and became more serious.

Many homes in Chiangmai still use water from shallow dug wells in their compounds for drinking and washing purposes. The water from wells is collected and kept in the jars for family use. This water can be dangerous when contaminated too, because the water from both deep and shallow wells has been shown to permit cholera vibrios to survive as long as ten days. This contaminated wells can play an important role in an epidemic as reported by Abou-Gareeb (1). He isolated a strain that belonged to Ogawa subtype as well as NAG vibrio strains from six open, shallow wells close to latrines. People who drank from this polluted wells developed cholera as much as six days following the discovery of the organisms in the water.

We can summarize the factors which influence the epidemiology and endemiology of enteric infection in Chiangmai with the following diagram:



Obviously, flood conditions are not the rule, but rather the uncommon occurrence; the epidemic situation is thus the prevailing one. Undoubtedly, the water jars play a major role here. The water jar gets contaminated by soiled fingers. Lack of washing facilities in the water closet (hong suam) and lack of tissue or a reasonable substitute lead to persistent contamination of the hands. The use of handleless dip pan to flush the water closet (hong suam) requires that the fingers also dip into the water. Thus each person contributes his flora to the water. The studies of Le Beau (33) showed that these jars frequently contain the same organisms which infect members of the family. The jar contamination cycle does not end here. There is usually another water jar located at the rear door of the house containing drinking water and the handleless dip pan. The members of the family use this pan to dip out water for drinking, and in doing so use fingers which were soiled earlier either from their own flora or that of the water closet (hong suam) jar. Thus they now contribute organisms to the drinking water jar.

Since this study has shown that the cholera vibrios and some other enteric pathogens will survive in such condition for a few days, it is obvious that this has become a dangerous small focus of infection. During the rainy season this source is even more dangerous as previously indicated because many people save rain water for drinking purposes; and this study has shown that cholera vibrios survive seven to ten days in such water, thus the threat to residents and visitors is evident. Actually it is this cycle

which can contribute most to perpetuation of the high endemicity of enteric infection in the early rainy season.

This problem is magnified in that during the late stages of the rainy season many religious festivals such as Loy Kratong and various Krathins gather people from far and near Chiangmai. At this season many jars of rain water are provided by generous residents throughout the city for thirsty people. This custom then provides further opportunity for spread of family flora to the whole community.