VOLUME XXI AUGUST, 1923 No. 4

CHOLERA AND THE SHIP "COCKROACH."

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FOR the past five or six years, epidemics of cholera have occurred every summer in Japan and the early cases in each outbreak are believed to have been imported from Manila or Shanghai.

Port quarantine in Japan has consequently been strict. Specimens of excreta from passengers and crew of vessels arriving from infected ports require to be examined bacteriologically and declared free before landing is permitted. The method is irksome and laborious though probably effective. During several years' experience as a ship surgeon, I had come to regard cockroaches with grave suspicion, especially during the summer months, as they are voracious feeders on all kinds of organic matter and creep over unprotected human food.

With regard to the species of cockroach prevalent on board ship, Brooke (1920) states that the great majority of ship cockroaches are *Periplanata americana*—a view shared by Melville-Davison (1911). Pryor (1918), however, finds that the most commonly encountered species is *Batta germanica*. On Japanese ships, my own experience has been that *B. germanica* is very common while *P. americana* is met with in small numbers. *B. orientalis* I have never seen. Barber (1914) in a study of *P. americana* as a possible carrier of the cholera vibrio reports that cockroaches which have fed on human cholera faeces may harbour vibrios in their intestines and that these may appear in the faeces for at least two days after the insects have fed, and, in reduced numbers, even 79 hours after ingestion. In Barber's opinion cockroaches may convey infection to human food either through infected vomit or faeces, and in human food so infected, vibrios may survive at least 16 hours after discharge from the insect. After 29 hours' sojourn in the intestine of the cockroach, cholera vibrios were not rendered less virulent for the guinea-pig.

AUTHOR'S EXPERIMENTS.

It was proposed to examine the faeces of cockroaches which had previously ingested cholera cultures and to determine how long the vibrios were capable of surviving in the intestines of the insects. The cockroaches, all belonging to the species *B. germanica*, were collected from Japanese liners and were all winged adults except one larva.

Methods. The method of experimentation was simple. Each insect was kept in an ordinary test-tube plugged with cotton wool until it became hungry,

the starvation period being generally one to three days, and, in a few cases, seven days. It was then transferred to another tube containing a small mass of bread soaked in an emulsion of *Vibrio cholerae* prepared from an 18 to 24 hours' culture. The majority of the insects took the food greedily but a few declined. The females were more voracious than the males but it was noted that females which were carrying the egg-case declined the food.

Only those cockroaches which were seen to consume the food were selected for experiment. After feeding, each insect was removed to another tube containing a small piece of filter paper on which the insect deposited its faeces. Samples were examined as soon as deposited, fresh pieces of filter paper being inserted daily.

Each insect was finally killed by chloroform and soaked for a short period in 2 % lysol. The intestine was then dissected out and samples taken from stomach, mid-gut and rectum.

All vibrios recovered were tested with a specific agglutinating serum. The cockroaches were kept in an incubator at a temperature of 18° to 22° C.

Results.

The number of insects used for experiment was 94, viz. 33 males, 41 females, 19 females carrying the egg-case, and one larva. Of these, evidence of infection as determined by examination of faeces or the intestine after death, was obtained in 14 instances (ca. 15 %), viz. four males, eight females, one female carrying egg-case and one larva. The annexed table shows the protocols of the cases in which a positive result was obtained.

Serial No.	Sex	Starvation period in hours	Date of feed	Examination of faeces at different dates			Examination of intestines after death
6	F.	48	17 July	−(24 hrs)	+(48 hrs)	−(72 hrs)	−(96 hrs)
15	M.	24	12 ,,	−(24 ,,)	+(48 ,,)	−(72 ,,)	+(120 ,,)
17	M.	24	12 ,,	+(24 ,,)	−(48 ,,)	−(72 ,,)	−(120 ,,)
28	F.	24	10 Aug.	+(24 ,,)	+(48 ,,)	−(72 ,,)	−(120 ,,)
35	M.	148	16 ,,	−(24 ,,)	−(48 ,,)	died (72 ,,)	+(72 ,,)
38	F.	72	25 ,,	+(24 ,,)			+(72 ,,)
44	F.	72	25 ,,	+(24 ,,)		−(72 ,,)	−(120 ,,)
45	M.	72	25 ,,	+(24 ,,)		−(72 ,,)	−(120 ,,)
50	F.	72	28 ,,	+(24 ,,)	−(48 ,,)	−(72 ,,)	−(86 ,,)
54	F.	72	28 ,,	+(24 ,,)	+(48 ,,)	−(72 ,,)	−(86 ,,)
57	Larva	72	28 ,,		+(48 ,,)	+(72 ,,)	−(120 ,,)
64	F.	24	5 Sept.	+(24 ,,)	+(48 ,,)	+(72 ,,)	−(144 ,,)
66	F.	24	5 ,,	+(24 ,,)	−(48 ,,)	−(72 ,,)	−(86 ,,)
82	F.	72	7 ,,	+(24 ,,)	+(48 ,,)	−(120 ,,)	−(144 ,,)

Summary and Discussion.

It would appear that in a fair proportion of cockroaches which have consumed food contaminated with *V. cholerae*, the mechanism by which ingested vibrios are rapidly destroyed in the interior of the insect, may fail. In such cases the faeces may contain viable vibrios for periods of 24 hours, 48 hours or even 72 hours after the infective feed. One insect (No. 35) in whose faeces

no vibrios had been detected at 24 hours and 48 hours, died on the third day after feeding and its intestine was found to contain enormous numbers of viable vibrios. On the whole, however, the conditions in the interior of the cockroach would appear to be as unfavourable to any prolonged sojourn of the vibrio as those met with in the interior of the house fly when similarly infected. Graham-Smith (1910) found that faeces of flies fed on cholera cultures remained infected for a period not exceeding 30 hours while the gut itself contained viable vibrios for a period not exceeding 48 hours. The exact nature of the mechanism whereby delicate organisms such as *B. typhosus* or *V. cholerae* are destroyed in the interior of insects is not fully known though there is considerable evidence that their survival is influenced by the presence of other bacterial species fully established in the insect hosts.

The epidemiological importance of the cockroach as a possible vector of cholera vibrios under conditions obtaining on shipboard or elsewhere cannot be overlooked though the evidence incriminating these insects is purely of an experimental kind.

REFERENCES.

BARBER, M. A. (1914). Cockroaches and Ants as carriers of the vibrios of asiatic cholera. *Phillipine Journ. of Sc.* IX. 1–4.

BROOKE, G. E. (1920). *Marine Hygiene and Sanitation.* (London, Baillière, Tindall, and Co.)

GRAHAM-SMITH, G. S. (1910). Observations on the ways in which artificially infected flies (*Musca domestica*) carry and distribute pathogenic and other bacteria. *Reports to Loc. Gov. Board on Public Health and Medical Subjects.* New Series, No. 40.

LAING, F. (1921). The Cockroach. *Brit. Museum (Natural History) Economic Series,* No. 12.

MELVILLE-DAVISON, W. (1911). *Ship's Hygiene.* (Bristol, John Wright & Sons, Ltd.)

MIALL, L. C., and DENNY, A. (1886). *Structure and Life History of the Cockroach.* (London, Lovell Reeve & Co.)

MORREL, C. C. (1911). The Bacteriology of the Cockroach. *Brit. Med. Journ.* 1911, II. 1531.

PRYOR, J. C. (1918). *Naval Hygiene.* (London, W. Heinemann.)