CARRIAGE OF COLIFORM BACILLI BY THE ORIENTAL HORNET (*VESPA ORIENTALIS* FABR.).

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THE large red Oriental Hornet (*Vespa orientalis* Fabr.) must be extremely familiar to all who served in Mesopotamia. The Rev. F. D. Morice, who has been good enough to identify my specimens, tells me that it can barely be distinguished from *Vespa crabro* L., the European hornet, except by its colour. It is widely distributed in the Mediterranean countries up to lat. 47° N. and occurs S. to Abyssinia and Madagascar, E. to India, and also as an introduced species in certain parts of S. America.

In Mesopotamia the nests are made in hollows in mud walls, under old roofs, in the brick sides of wells and similar situations. The hybernated females appear in the early spring, and workers are first seen in mid-June. During August, September and October they are exceedingly abundant and sometimes conceal from view the joints of meat on which they are feeding in the butchers' shops. They also devour all sorts of fruit, particularly fresh dates in the bazaars. It is a matter of common knowledge that this insect feeds on all forms of household refuse, especially faeces of men and animals, and the dried carcases that one finds so frequently on the edge of Arab towns. I once observed hundreds of workers gorging themselves at a stream of blood and putrid offal which oozed from beneath the door of the Jewish slaughter house in Baghdad; this was in September 1917.

Graham Smith (1916, p. 504) has recorded visits of common wasps to traps baited with human faeces in Cambridge. I know of no other reference to this habit of the wasp.

During the summer and autumn of 1918, while I was serving in the Central Laboratory, Amara, Mesopotamia, I devoted a little time to examining the bacteria carried by this foul-feeder. I microscopically examined the contents of the gut of 58 workers, and prepared plate cultures from 64 on MacConkey's bile salt-litmus-lactose medium, with the following results.

Dissections. I began the series of dissections expecting to find cysts of intestinal protozoa, and eggs of intestinal worms, just as one finds them in the house-fly. My method was to examine the gut contents after treatment with iodine. It soon became apparent that the digestive processes of the hornet are rapid and complete. If a hornet is fed experimentally on human faeces, and dissected an hour after feeding, nothing recognizable as faeces can be found in the gut. The 58 wild-caught hornets I examined were from

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slaughter houses and butchers' shops, dumps of household refuse, fruit stalls, and the sides of the porous clay water-coolers known in Arabic as "hab." The hornets were killed at once but 34 of them contained no solid matter of any sort in the gut, 20 contained débris and four "apparent faeces." I have already discussed the points which lead one to conclude that any given material in the gut of the house-fly is human faeces (see Buxton, 1920). I found no eggs of parasitic worms or cysts of protozoa in the "apparent faeces" on these four hornets. One of the four was eating dates in a fruit stall, the three others on different days drinking water from the outside of a water cooler in the billet of the Assistant Director of Medical Services. The material recorded as débris consisted for the most part of fine grit, which I presumed to be dust, accidentally ingested with the food. The result of the dissections was therefore as follows:

No. of workers dissected	58
No. of guts containing no solid matter	34
No. of guts containing débris, mostly mineral	20
No. of guts containing "apparent faeces"	4

Platings. The rapidity of the hornets' digestive processes seemed to indicate that any results obtained from dissection would be misleading, because only a few of these workers which had been feeding on faeces would be found to contain material which could be recognized microscopically as faeces. The series of workers whose organs were plated shows that this was the case and that the hornets were much more frequently infected with intestinal bacteria than one would have guessed from the dissections alone. Hornets for plating were collected in a sterile tube and carried in a wet towel to the laboratory in order to keep them cool; they always arrived alive. As is very well known (Buxton, 1914; Latter, 1913), Hymenoptera die quickly in hot weather if they are confined in a tube or small box. The insects were dissected with aseptic precautions. In the case of the first dozen insects the mouth-parts, legs, wings and various parts of the gut were plated separately on MacConkey's medium. I found that if a hornet was carrying coliform organisms at all, I could generally recover them from all parts of the body within and without. Subsequently I merely broke up the insects in sterile broth and plated a loopful of the fluid on MacConkey's medium. A very great number of species of bacteria frequently grew in spite of the bile-salts present in the medium. Agar subcultures of suspicious colonies were tested with such sugars as were available, and the motility of the organism and its reaction to litmus milk and Gram's stain noted.

The Table (p. 70) shows the coliform bacilli in three groups. Group *a*, lactose-fractors of uncommon types, each of which was isolated once only, the first two from the same hornet. I do not regard the recovery of these bacteria as evidence of faecal contamination. Group *b*, common lactose-fractors. Each species was found a number of times, often two species in one hornet. Of 64 hornets plated 23 were found to be infected with one or more of these

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common intestinal organisms, which were generally present in immense numbers when present at all. I tested more than half the bacilli in this group not only with the five sugars mentioned in the Table but also with dextrin, maltose, salicin, litmus milk and the Voges Proskauer reaction. All those tested agreed in every particular with the well-known inhabitants of the intestine with which I have identified them. Group *c*, an organism which gave the cultural reactions of Shiga's bacillus, was found on three of the 64 hornets: from one of these individuals I also isolated what appeared to be Morgan's No. 1 bacillus, and a fourth hornet yielded Morgan's bacillus without the Shiga-like organism. These non-fermenters of lactose occurred

Table showing various species of coliform bacteria isolated from Oriental Hornets at Amara, Mesopotamia, in the summer of 1918.

Group	Number of occurrences	Litmus broth: Lactose	Glucose	Dulcite	Mannite	Saccharose	Motility	Name
a	1	*AG*	*AG*	*O*	*O*	*AG*	?	? *
	1	*AG*	*AG*	*O*	*AG*	*O*	+	*B. grünthali* *
	1	*AG*	*AG*	*O*	*AG*	*AG*	+	*B. cloacae* *
b	6	*AG*	*AG*	*AG*	*AG*	*O*	+	*B. coli communis*
	8	*AG*	*AG*	*AG*	*AG*	*AG*	+	*B. coli communior*
	11	*AG*	*AG*	*O*	*AG*	*AG*	–	*B. lactis aerogenes*
	3	*AG*	*AG*	*O*	*AG*	*O*	–	*B. acidi lactici*
c	3	*O*	*A*	*O*	*O*	*O*	–	*B. dysenteriae* (Shiga)
	2	*O*	*AG*	*O*	*O*	*O*	+	Morgan's No. 1 bacillus

* These three organisms were not investigated in detail. The last two agree with *B. grünthali* and *B. cloacae* as far as sugars are concerned. They may or may not have been derived from faeces; for the purpose of the present paper, which proves that *Vespa orientalis* is a carrier of faecal organisms, it is immaterial whether they were or were not!

sparingly among rich growths of one or other of the organisms of Group *b*. Capt. G. Shanks, I.M.S., was so kind as to test the three organisms which had the cultural characters of Shiga's bacillus, with specific agglutinating serum: none of them were agglutinated except at insignificantly low dilutations. We had no specific serum with which to test Morgan's bacillus on the two occasions on which we isolated it. In spite of this I think these platings give us undeniable proof of the carriage of bacteria derived from faeces by these hornets. Had I only found a single type of coliform bacillus giving, let us say the familiar sugar reactions of *B. coli communis*, it might easily have been explained by supposing that these hornets normally harboured a "coli-like" organism which was not faecal in origin, but could not be distinguished from *B. c. communis* by any of the tests applied. Such an explanation does not meet the case we are considering. In these hornets which are known devourers of human faeces, four types of bacilli are commonly found: these agree in every criterion which can be applied with the common faecal organisms *Bacillus coli communis*, *B. c. communior*, *B. lactis aerogenes* and *B. acidi lactici*: among these lactose-fractors we find much more rarely organisms resembling Shiga's bacillus and Morgan's No. 1 bacillus, and these organisms never occur except along with the lactose-fermenters. We may therefore safely assume that we have been correct in our identification of these bacilli, and that at any rate the majority of them were derived from faeces.

The relative frequency of the organisms in Group *b* attracted my attention. As previously stated I isolated *B. coli communis* six times, *B. c. communior* eight times, *B. lactis aerogenes* eleven times, and *B. acidi lactici* thrice. The commonness of *B. lactis aerogenes* may be due to its being able to withstand some unfavourable condition in or on the hornet for a longer period than the other types can. It was suggested to me that the sugar reactions of these bacilli might change while they are in the hornet's gut: I know no shadow of evidence which might support this view. I subcultured a number of these Group *b* organisms daily for 15–20 days, but their sugar reactions remained unchanged.

The result of the platings was therefore as follows:

No. of hornet workers examined	64
No. from which coliforms were isolated	23
No. from which pathogenic coliforms were isolated	4

(viz., Shiga twice, Morgan once, Shiga and Morgan once).

Conclusion. The Oriental Hornet (*Vespa orientalis* Fabr.) frequents piles of domestic refuse and human faeces, also fruit shops. It appears to digest what it eats rapidly, so that microscopic examination of the gut contents does not give us a correct idea of the very high degree to which it is contaminated. Sixty-four workers were plated; of these twenty-three were carrying well-known types of intestinal bacteria. I state that these bacteria were faecal, not that they *resembled* well-known faecal organisms for these reasons: they agreed in every test with the species with which I have identified them; the lactose-fermenters were common, and those which did not ferment lactose were rarer, and occurring always among the lactose-fermenters.

On the whole I concluded that the individual hornet is probably nearly as heavily infected with pathogenic coliform organisms as the individual house-fly; it is however not so exceedingly common as that insect, and it rarely enters mess-rooms and kitchens. As a spreader of infectious disorders of the bowel it is probably of very slight practical importance. It will be time enough to open a campaign against the hornet when the spring and autumn fly-plague in the Arab towns is a thing of the past.

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