has easily informed me that a soft murmur accompanied and followed the clear second sound. It is extraordinary how constantly it is forgotten in practice that the second is a double sound, that it contains a pulmonary as well as an aortic element. To this fact and to the propagation of errors by means of textbooks, as well as to the causes already indicated, I attribute the mistake.

THE DEVELOPMENT OF FILARIA NOCTURNA IN DIFFERENT SPECIES OF MOSQUITOS.

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The two common species of *Culex* found in St. Lucia are a brown insect very closely resembling *Culex pipiens*, which Theobald, in specimens sent home to England by Dr. Grey, of Castries, has identified as *Culex fatigans*, and a smaller, brownish-black insect with white-banded legs, the common *Culex teniatus*. The latter is very bloodthirsty, feeding by night or day, whereas the former, which is also less plentiful, only feeds by night. Both these species were fed on a patient with numerous filaria nocturna embryos in his blood, to ascertain to what extent they might act as efficient hosts for the spread of filarial disease.

The results as regards *Culex fatigans* are of special interest, because they tend to confirm the original observations of Manson in Amoy as to the time taken for the final metamorphosis of the embryonic forms of filaria nocturna in the body of the mosquito.

Technique.

Larvæ collected from waterbutts, tubs, and similar situations were placed in teacups in small wooden boxes, $1\frac{1}{2}$ ft. long, by 1 ft. broad, and 1 ft. high, each of the sides being covered with gauze to admit air. At one end a door closed by a sleeve of gauze was constructed, large enough for the hand and arm to be easily passed into the house. In a few days many of the larvæ became transformed into insects. In the evenings about 9 P.M. the patient simply placed his hand and arm in the box, and all the mosquitos which bit him were then caught in ordinary test tubes and transferred to a separate box, where they were kept till required for dissection. No trouble was experienced in keeping the insects alive. They were fed on bananas and brown sugar. A certain proportion of males were kept with the infected females, and many of the latter deposited their eggs in small glass vessels full of water kept for the purpose in the boxes. This method of infecting mosquitos is simpler than introducing them under the mosquito net of a patient's bed at night. None are lost, and the trouble of collecting and separating them is reduced to a minimum.

Experiments on *Culex Teniatus*.

On dissecting insects of this species twelve to twenty hours after feeding, many actively-moving filaria embryos are seen in the muscles of the thorax; they have then no trace of the long sheath which encloses them while circulating in the human blood.

Four and a-half days after infection the embryos show some development; they are now longer and broader, and show with a high power some increase in the number of the cells of the body. A fine cuticle, ending in a sharp point some distance behind the tail, encloses them.

At seven and three-quarter days they have become distinctly sausage-shaped; the mouth is now visible, and the body cells are becoming arranged to form the alimentary canal. Many show the usual hernial protrusion at the anus; all still have the fine cuticle.

At dates later than this (eight and three-quarter days) some have changed from the sausage stage, becoming now elongated, and there is further increase in the cellular structure. Later than this, from nine days onwards, though occasionally seeing a more developed form with a fairly distinct alimentary canal, the growth of the embryos seems to come to a standstill. Instead of rapidly increasing as inefficient hosts they begin to degenerate, the cells of the body becoming granular, and the intestinal canal very indistinct.

At fourteen days nearly all have disappeared, only small imperfectly-developed ones remaining. Some of these are still alive, and move feebly.

At seventeen days only about one out of ten insects shows anything, and the embryos seen are either dead or degenerating. At twenty days after infection no trace was to be seen of filariæ in many mosquitos dissected.

The conclusions, therefore, one must arrive at as regards *Culex teniatus* are that this insect is not an efficient host, a fact already hinted at by Dr. Rees¹ at the last meeting of the British Medical Association. Though the embryos migrate to the thorax and undergo some development, yet none ever reach maturity, and therefore never pass to the proboscis, a very fortunate circumstance for St. Lucia and other places which harbour this troublesome pest.

Experiments on *Culex Fatigans*.

In marked contrast to the slow and imperfect development of the embryo in *Culex teniatus* is the extremely rapid rate of growth they exhibit in the thoracic muscles of *Culex fatigans*. In twelve to twenty hours after feeding large numbers have arrived in the muscles, and even in forty hours show a considerable amount of change. There is increase in the number of the cells, and the fine cuticle can be seen tapering to a point posteriorly.

By the end of four and a-half days the sausage stage has been reached, the alimentary canal has begun to form, and the mouth and anus are visible. They are now larger and stouter than the stage described in *C. teniatus* at seven and three-quarter days. Growth now goes on with great rapidity.

At five and a-half days they have lengthened out, the anatomical structures being better marked.

At six and a-half days they are still longer; mouth, anus, and alimentary canal are very distinct and well formed, and on the following day the cesophageal bulb has appeared; most have lost the fine cuticle, and some show the commencement of the trilobed tail.

At eight and a-half days they measure 0.88 mm. in length by 0.04 mm. in breadth; the large cells which originally formed the intestinal tube having at this date become transformed into fine small cells, and the whole appearance very much resembles that seen in the final stage of development. The next two days are taken up with a further increase in length.

At ten days and a-half forms measuring 1.26 mm. ($\frac{1}{8}$ in.), to 1.3 mm. in length by 0.04 mm. in breadth, are seen. Anatomically they present a mouth, an cesophagus, an cesophageal bulb, and a long alimentary canal ending at the anus, which is situated some little distance above the trilobed tail.

Movement is now very active; though they do not change their positions on the slide they are constantly twisting and coiling themselves about in what has been called a purposeless manner, very much resembling the movements of the immature embryos when seen in a drop of blood.

By the following day (eleven and a-half days) metamorphosis is complete, and mature forms are seen in the head and neck, and proboscis, and more rarely in the abdominal cavity. One is at once struck by the fact that the embryos vary considerably in length, and also that the thoracic muscles still show a number of very short filariæ which have developed much more slowly; this corresponds to what was seen in sections of mosquitos made by myself in London from material sent home by Dr. Bancroft. Measurements give for the longest of the mature embryos 1.6 mm. ($\frac{1}{8}$ in.), while one dissected out of the proboscis only attained to 1.44 mm. ($\frac{1}{4}$ in.), and another in the muscle was as small as 1.26 mm. ($\frac{3}{8}$ in.). The breadth varies from 0.024 mm. to 0.032 mm.—that is, they are finer than those seen at ten and a-half days. None as large as $\frac{1}{2}$ in., the limit given by Bancroft, were seen. Whence, then, arises the great difference in the times given for complete metamorphosis by Manson in 1879 and 1883,² and more recently by Bancroft in Australia.³

James⁴ has already entered into this question. Working with *Anopheles Rossii*, he found that twelve to fourteen days are required for the complete development, and he puts forward the view that climate and probably other factors have an important influence on the development of the parasites.

This question of temperature is, I think, the prime factor in the variability. Manson's experiments were done in Amoy, Bancroft's in Queensland, and James's on *Anopheles* in Travancore. The above observations were conducted in Castries, St. Lucia, in the month of March, and it is quite possible that if they had been done later in the hot weather the complete metamorphosis might have taken place as early as the eighth day, the time originally stated by Manson.

The facts of the case may be summed up thus: Some mosquitos are inefficient hosts, the embryos never migrating from the stomach; some are partially efficient, the embryos reaching the muscles, where they undergo a partial development and then become absorbed; while others are properly efficient, the time taken for complete metamorphosis varying with the temperature and other climatic influences of the place in which the experiments are conducted.

Experiments to determine the Intermediate Host of Filaria Demarquaii.

So far those experiments have proved entirely negative. Three different species of mosquitos—*Anopheles albipes* (Theobald), *Culex tenellus*, and *Culex fatigans*—all reared as usual from larvæ, were fed on a patient with the embryonic forms of *Filaria Demarquaii* in his blood. On dissecting such insects twelve hours after feeding, plenty of embryos living and very active were seen in the blood from the stomach. Twenty-four hours afterwards many of the mosquitos had entirely digested their meal of blood, but in those that retained any the embryos were still visible, showing no increase in size and now moving more languidly. At later dates the filariæ die, become digested, and disappear, and never migrate to any of the tissues of the insects. Those three species, therefore, do not act as efficient hosts for the spread of this parasite. Some blood-sucking insect must be responsible, however, as an intermediate host, and further experiments are in progress to try and determine this point.

REFERENCES.

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NOTE ON THE VALUE OF EXPERIMENTS IN THE QUESTION OF FOOD PRESERVATIVES.

By A. S. GRÜNBAUM, M.D., D.P.H.

In a recent laborious investigation¹ on the influence of boric acid and borax upon the general metabolism of [three] children, the authors come to the following, amongst others, general conclusions:

1. Continued administration of 1 gram of boric acid or 1.6 gram of borax has no influence in healthy or delicate children upon proteid metabolism.
2. The body weight was increased in all cases, especially in the case of the delicate child with borax.
3. Phosphorus metabolism is practically unaltered.
4. Both boric acid and borax were quickly eliminated, no cumulative action being therefore probable.
5. Neither boric acid nor borax in any way affected the general health and well-being of the children.

The advisability of permitting or prohibiting the addition of preservatives to food does not depend entirely upon the fact of whether experiment shows them to be harmless or harmful. It is therefore dangerous from an administrative and hygienic point of view that the result of a few experiments should be published without any indication as to what they do or do not show in relation to the main question.

Experiments on man are necessarily limited in number and in time; they may for these reasons be less valuable than experiments on animals. In the paper already alluded to only the results and general conclusions are given, yet the total impression given by reading the paper is that the authors find nothing to condemn in the use of these preservatives in milk. This investigation therefore forms a convenient text for a consideration of the value of such experiments.

Number of Experiments.

Only three were made in the investigation referred to, and the results were negative—namely, "neither boric acid nor borax in any way affected the well-being of the children."

Obviously very little weight can be attached to negative results of three experiments, even if they are all concordant, especially since positive results of injury are on record.

Time of Experiments.

The period of administration was only twelve days. This is a rather short time from which to draw general conclusions.

Age.

The age of the children varied from 2½ to 5 years—that is, well over the age in which milk usually forms the only article of diet, and the age at which the alimentary canal is most sensitive.

General Considerations.

But the mere fact that the metabolism remained practically unaltered is not *per se* evidence that the boric acid compounds caused no injury.

There are a few details in the paper open to criticism. Boric acid, as well as borax, has a distinctly inhibiting effect on the rennet ferment if added in proper solution. This is to be expected, because insoluble calcium borate is formed. To neutralise this effect not merely "a small quantity," but at least an equivalent quantity, of calcium chloride must be added. In order not to destroy the effect of the borax, calcium chloride can only be added to the drugged milk just before consumption.

Although I believe it is correct that no erythematous rashes have been recorded through taking borax with food, the authors have omitted to mention the far more important fact that other more serious toxic effects, which could hardly have been due to anything else, have been recorded² as the result of taking milk drugged by the dealer with borax.

The quantities of borax given were certainly much less than that required to inhibit bacterial growth in milk and less than required to preserve milk for twenty-four hours in summer.

The question of harmfulness or otherwise can only be judged from general considerations. It is impossible to judge from an experiment of two or three weeks' duration whether taking a drug over a lengthened period, especially in infancy, may not affect the length of a man's life. Since, therefore, we cannot make conclusive experiments, we must make deductions from known facts. (Unfortunately magistrates are incapable, as a rule, of understanding general principles, and also lay more stress on an experiment done by a tyro witness than on any which can be quoted from a scientist of acknowledged ability. Hence the frequent conflict of evidence and conflicting decisions, with a resulting unsatisfactory administration of the Foods and Drugs Act.)

There is no reason to suppose that any ordinary organic or inorganic substance which will injuriously affect a cell like a bacterium does not also injure the cells of the alimentary canal. (The specific antitoxins and similar bodies are of course exceptional.) The repair of these injured cells throws a strain on the organism which it would not have had without the addition of the preservative to the food.

The fact that the commonly employed antiseptic preservatives are rapidly eliminated by the kidneys, either unchanged or only slightly changed, is, to my mind, the most conclusive evidence of their poisonous character. It throws an uncalled-for burden on the normal kidney, and where the kidney is no longer normal, may be positively dangerous. I may mention here that, contrary to Rosenheim's and Tunncliffe's observations, others have seen accumulation of boric acid.

Into the question of the desirability of prohibition from a hygienic point of view it is hardly necessary again to enter. It has sufficiently often been pointed out that the use of preservatives tends to dirtiness and fraud; it has often been pointed out that they are unnecessary. Some recent remarks of Dr. Abel,³ Medical Officer of Health of the City of Hamburg, may appropriately bring this note to a close:

The assertion that a general prohibition of the use of antiseptics would destroy large industries and raise the price of important foodstuffs for the people is a tremendous exaggeration. It is not so long ago that it was said, and it is still asserted in England, that milk could not be supplied to large cities without preservatives. Yet how well it can already be done, and how much better still it will be done in the future.

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¹ Rosenheim and Tunncliffe, *Journal of Hygiene*, vol. i. No. 2. ² Hope, *Thompson-Yates Laboratories Reports*, vol. iii, p. 76. ³ Abel, *Hygienische Rundschau*, vol. xi, p. 268.