below normal. Whether children bleed at a lower level than adults, so that a fresh set of standards must be devised for them, it is not now possible to say. A partial explanation of the lower maternal and fetal values may be that all of these tests were run during the winter, when the intake of foodstuffs containing vitamin K is less than in the summer months.[5]

Summary. A serial study of 11 parturient women and their infants by the serum volume index confirmed the findings of others, by other tests, that a definite tendency to hemorrhage exists in infants for a short time shortly after birth.

11227 P

Fleas as Acceptable Intermediate Hosts of the Dog Heartworm, *Dirofilaria immitis.*

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The method of natural transmission of the dog heartworm, *Dirofilaria immitis,* is still incompletely elucidated. The larvae of this parasite have been shown to develop in many species of mosquitoes and, thus, mosquitoes have been believed to be incriminated in the natural transmission, but substantial proof of this is lacking. The possibility that other blood-sucking arthropods serve as transmitters was overlooked until 1921, when Breinl[1] reported finding the microfilarial embryos of *Dirofilaria immitis* in the fleas, *Ctenocephalides canis* and *Ctenocephalides felis,* collected from heartworm infected dogs in Australia. He also observed the advanced stages of development of this parasite in the Malpighian tubules of the fleas and the infective stage larvae in the hemocelic cavity. Recently, Brown[2] has observed the microfilariae and partially developed larvae of this parasite in *Ctenocephalides canis* collected from heartworm-infected dogs in the eastern United States.

In November of 1938, the writer, in examining dogs for heartworm infection in New Orleans, observed the typical microfilariae of *Dirofilaria immitis* in *Ctenocephalides canis.* The early developmental stages and the infective larvae were also seen in the hemocelic

1 Breinl, A., *Ann. Trop. Med.,* 1921, **14**, 389.

2 Brown, H. W., *The North Amer. Veterinarian,* 1939, **20**, No. 1.

cavity of fleas collected from a dog having a heavy infection. On other dogs harboring *Dirofilaria immitis Ctenocephalides felis* and *Pulex irritans* were found similarly infected. The female fleas of the 3 species were much more frequently infected and were more heavily infected with all the larval stages of the parasite than were the males. From some dogs infected with heartworm as many as 100% of the female fleas examined contained one or more infective-stage larvae and many of the earlier stages of development. The males harbored these stages only in small numbers and rarely contained the infective stage larvae.

Fleas of these 3 species collected from uninfected dogs have been experimentally infected in the laboratory in New Orleans and the extra-mammalian phase of the life cycle of *Dirofilaria immitis* has been completed in 10 such experiments undertaken. Sections of the infected fleas showed that the parasite, in the typical microfilarial stage as found in the dog's blood, had entered the ventral part of the hemocelic cavity in the region occupied by the fat bodies and had there begun its development. The metamorphosis of the parasite from the microfilaria to the infective stage larva followed closely that found in various species of mosquitoes infected here[3, 4] and by other workers elsewhere. The microfilaria developed into a shortened, so-called sausage larva, identical with that found in experimentally infected mosquitoes. By gradual elongation of the body and development of the internal structures this sausage larva became the infective stage larva, which was morphologically identical with that developing in mosquitoes, although the time required for complete development in the flea was much shorter than in any mosquito worked with here or as yet reported in the literature. Thus far the minimum time required for development in the flea, from the microfilarial to infective stage, was 120 hours as compared with 240 hours in species of mosquitoes experimentally infected here. In addition, the writer's observations indicate that the microfilaria did not begin its development in the Malpighian tubules, as Breinl had stated for fleas and as occurs in mosquitoes, but rather in the hemocelic cavity.

In experiments conducted with fleas during the months of June and July it was found that the infective stage larva of *Dirofilaria immitis* appeared in 120 hours as compared with 216 hours in the same species of flea in experiments conducted in December and January. Observations as yet incomplete seem to indicate that during

[3] Hinman, E. H., *Am. J. Trop. Med.*, 1934, **15**, 371.

[4] Writer's observations.

the warmer season of the year the time required for development is shorter than during the colder season. With decreasing temperature the time required for development increases and *vice versa.*

In summary, the fleas, *Ctenocephalides canis, C. felis* and *Pulex irritans,* collected from dogs harboring *Dirofilaria immitis,* have been found naturally infected with the microfilarial and larval stages of this parasite. The female fleas seemed much more susceptible to the infection than the males. All 3 species of fleas have been experimentally infected and in all 3 the extra-mammalian phase of the life cycle has been completed. The time required for this development in fleas was 120 hours in warm weather and 216 hours in cold weather. This phase of the life cycle was more rapidly achieved in fleas than in mosquitoes. It appears that both biologically and epidemiologically fleas are more suitable intermediate hosts of *Dirofilaria immitis* than had been previously supposed.

11228 P

Hyperthyroidism and Liver Function in Relation to B Vitamins.

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Many authors have reported that the liver becomes altered both structurally[1] and functionally[2] during hyperthyroidism. One of the most marked changes in the liver during the experimental and clinical hyperthyroid states is a depletion of the liver glycogen.[1, 3] A high carbohydrate diet is usually given to hyperthyroid patients in an effort to promote glycogen storage in the liver.

Abelin[4] and Abelin, *et al.*,[5] showed that large amounts of casein, egg yolk, or yeast would lessen the liver damage of the thyroid-fed animals, and Drill[6] was able to prevent a fall in the liver glycogen of

1 *cf.* Frazier, C. H., and Brown, R. B., *Trans. Am. Assn. for Study of Goiter,* 1935.

2 Maddock, W. G., Pedersen, S., and Coller, F. A., *J. Am. Med. Assn.,* 1937, **109**, 2130. *cf.* reference1.

3 John, H. J., *J. Am. Med. Assn.,* 1932, **99**, 620.

4 Abelin, I., *Biochem. Z.,* 1930, **228**, 165.

5 Abelin, I., Knochel, M., and Spiehtin, W., *Biochem. Z.,* 1930, **228**, 189.

6 Drill, V. A., *J. Nutrition,* 1937, **14**, 355.