

Survey of the Incidence of Ascarid, *Toxocara canis* in Dogs, with Special Reference to the Postnatal Infection as Compared with the Prenatal Infection

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Many works have demonstrated the occurrence of the prenatal infection of *Toxocara canis* in dogs or foxes under natural conditions (FÜLLEBORN, 1921a; YOKOGAWA, 1923; FOSTER, 1933; PETROV, 1941; NIFONTOV, 1949; YUTUC, 1949; KAMEGAI & KANEKO, 1950; NODA, 1954; YUTUC, 1954; SHIMIZU, HORIMI & FUTAHASHI, 1954; SHIMIZU & HORIMI, 1955) and experimentally (FÜLLEBORN, 1921b; SHILLINGER & CRAM, 1923; AKAGI, 1926a; AUGUSTINE, 1927). Particularly, recent workers (PETROV, 1941; NIFONTOV, 1949; NODA, 1954; SHIMIZU, HORIMI & FUTAHASHI, 1954; SHIMIZU & HORIMI, 1955) have shown the high occurrence in dogs or foxes under natural conditions. As for the postnatal infection of this worm in the definitive host, although some suggestions (LEUCKART, 1876; FÜLLEBORN, 1921b; HOEPLI, FENG & LI, 1949; SPRENT, 1952, 1953a, 1954) and many informations (FÜLLEBORN, 1921b; MATSUBARA, 1923; YOKOGAWA, 1923; TOCHIHARA, 1923; NISHIGORI & OBA, 1924; HIRASAWA, 1927; SAEKI, 1929a, b, c, d; HASHIMOTO, 1931; HIRATA, 1935a, b, c; NAKAJIMA, 1938, 1939; IDO, 1951, 1952; SPRENT, 1953b; PETROV—cited by SPRENT, 1954) have been obtained, the problem has not yet been elucidated in detail.

Many workers have reported the results of the surveys on the incidence of this worm in dogs under natural conditions. All these workers agree in the high occurrence of this worm in dogs under about one year of age in contrast to the low occurrence in olders. Some of these reports will be cited below :

ITAGAKI (1919), by the fecal examinations, found the occurrence of this worm in 84.0 per cent. of 25 puppies under three months of age, in 37.1 per cent. of 62 dogs from three months to one year of age and in 15.2 per cent. of 118 adults over two years of age. YOKOGAWA (1923) reported the occurrence in 88.2 per cent. of 34 dogs under one year of age and in 10.3 per cent. of 117 adults over one year of age. SUGIURA (1925) reported on the more decreased infections in older dogs. AKAGI (1926b) found this infection in 31.8 per cent. of dogs over one year of age, in 92.8 per cent. of puppies under three months of age and its rarity in dogs over four months of age. He later (1931) found the occurrence in 29 of 31 puppies under three months of age (93.5 per cent.) and in only 3 of 27 dogs from three months to nine years of age (11.1 per cent.). MINOWA (1928) found the occurrence in 67 per cent. of dogs under four months of age, in 3 per cent. of dogs over six months of age and none in 55 adults over one year of age. SAEKI (1929) found the infections in 77.78 per cent. of puppies under two months of age and in 74.02 per cent. of puppies under three months of age in the survey of 1926, and in 86.76 per cent. of puppies under three months of age, in 80.43 per cent. of puppies under four months of age and none of dogs over seven months of age in the survey of 1927. He also found gradual decrease in elimination of eggs in feces beginning about two months after birth. HIRATA (1935c) found this worm in only two dogs, in which was involved one bitch which gave birth to puppies twenty-seven days before autopsy, out of all ninety-two dogs over two years of age. HINMAN & BAKER (1936) found rare infection in adult dogs (0.5 per cent.) and rather infrequent even in puppies (4.7 per cent.). YOSHIKAWA, NISHIMURA & UESUGI

(1936) found the infections in 47.6 per cent. of 42 young dogs from three to six months of age, in 10 per cent. of 70 adults from three to five years of age and in 5.3 per cent. of 38 seniles over eight years of age, and later (1938) in 69.3 per cent. of 78 youngs from three to six months of age, in 10 per cent. of 198 adults from three to five years of age and in 8.3 per cent. of 24 seniles over eight years of age. ADACHI (1952), from the observations on 2214 clinical cases, stated that the highest occurrence was observed in puppies about four months of age, but few in dogs over nine months of age and none in dogs over eleven months of age. YAMASHITA & MORI (1953) reported on few infections in dogs over four months of age in contrast to high occurrence in youngers.

It seems, however, that the considerations upon whether the worms found in dogs are derived from the prenatal or postnatal infections have been neglected. An attempt to differentiate these worms into the prenatal and postnatal infectors may not be unworthy in order to elucidate the problem of the postnatal infection.

As reported previously (1954), the prenataally infecting worms recovered from puppies at birth are almost the same in size, and in addition, they later grow almost regularly as described below. These facts may suggest the possibility to differentiate the worms of both modes of infections from each other by the comparison of their size.

Moreover, the days required for the prenatal infecting worms to pass eggs in fecces were examined in the same way as described in the previous paper (1954).

Materials and Methods

Experiment-1: One hundred dogs, from one month to five years of age, were autopsied between September 20, 1950 and November 22, 1952, and the presence and number of both male and female of the worm in the alimentary canal was examined by naked eye. Therefore, the small forms might be overlooked.

Experiment-2: Sixty-three dogs, from five days to six years of age, were autopsied between April 18, 1952 and August 21, 1954. The alimentary canal was removed, and each of the stomach, small intestine, cecum and large intestine was searched for worms; In some cases the small intestine was divided into four portions of equal length. Each portion was splitted open and then washed several times with distilled water. Washing water was collected into the glass cylinder, left stand for about thirty minutes, and then supernatant was discarded. This procedure was repeated until supernatant became clear. Then the sediment was transferred to the watch glass and searched for worms by naked eye and under the binocular dissection microscope. The worms collected were killed with hot water and then fixed by adding 5 per cent formol solution. The differentiation of the sexes and the measurement of the body length were performed by naked eye on large worms and/or under the microscope on small worms. The determination of the modes of infection on these worms was done by comparing their size with that of the prenataally infecting worms reported in the previous paper (1954).

Results and Discussion

Experiment-1: The results obtained are shown in Table 1. It shows that the infections occur in all of four puppies under three months of age, and in thirteen of forty-eight from four months to about one year of age, but not at all in forty-eight over two years of age.

Table 1. Survey of the incidence of *T. canis* in 100 dogs
(from Sept. 20, 1950 to Nov. 22, 1952)

Age group	1 mo.	2 mo.	3 mo.	4 mo.	5 mo.	6 mo.	1 yr.	2 yr.	3 yr.	4 yr.	5 yr.
No. of dogs infected	1	2	1	2	1	1	9	0	0	0	0
No. of dogs examined	1	2	1	5	2	2	39	27	15	5	1

Experiment-2: It is shown from Table 2 that the infections occur in all of thirty-four puppies sixty days of age or younger, in six of eight dogs from three to four months of age and in three of twelve from six months to one and a half years of age, irrespective

Table 2. Survey of the incidence of *T. canis* in 63 dogs
(from Apr. 18, 1952 to Aug. 21, 1954)

Age group	5-60 dy.	3 mo.	4 mo.	6-14 mo.	16 mo.-1½ yr.	2-6 yr.
No. of dogs infected	34	0	6	0	3	0
No. of dogs examined	34	1	7	7	5	9

of the number and size of the worms, but not at all in nine over two years of age. These findings, together with those of *Experiment-1*, may

demonstrate that the occurrence of this worm in dogs is very frequent until about four months after birth, but since then gradually decreases as the host grows older, resulting in few infections in dogs over two years of age. It is interesting to point out that, as shown in Table 2, in spite of no infestation in seven dogs from six months to one year and two months of age, positive results are obtained in three of four bitches from one year and four months to one and a half years of age, which are examined from ten to forty-six days postparturition as shown in Table 3. This finding is in accordance with that of AUGUSTINE (1927), who has found the infestation in a postparturient bitch about one and a half years of age, but none in another about three years of age, following the oral administrations of the embryonated eggs of this worm, with that of SAEKI (1929b), who has found the infections in the pregnant or postparturient bitches and ascribed this phenomenon to the effects of the sex hormones, and with that of HIRATA (1935c) as cited above.

The body length of the prenatally infecting worms reported in the previous paper (1954) and nowly obtained is shown in Fig. 1. The writer concluded in the previous paper that the growth rate of the prenatally infecting worm was considerably irregular. But this conclusion is too emphatic in its irregularity. From this Fig. it could be understood that the size of these worms increases almost regularly as the host grows older.

The prenatally infecting worms measure about one millimeter in length at birth, in

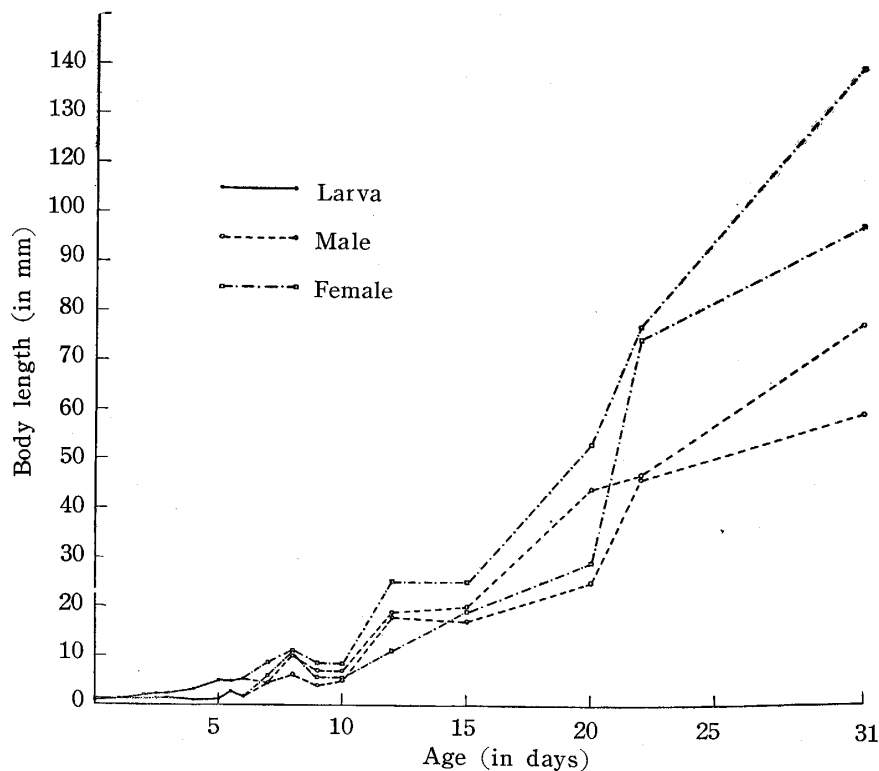


Fig. 1. Body length of prenatally infecting *T. canis* in relation to age.

contrast to less than about 0.4 mm. in length in the larvae newly hatched. In other words the difference in the body length between the prenataly infecting worms at birth and the worms which infect postnatally, if any, at the same time is considerable. Thus it may be expected that this difference continues to sustain later, because the latter worms will at most grow in the same rate as the former. Therefore, the differentiation of both worms from each other may be possible by comparing the size of the worms recovered in this examination to that of the postnatally infecting worms presented in Fig. 1.

The results of the comparisons thus made are shown in Table 3, and Table 4 shows the occurrence of these both infections in relation to the host age. In the hosts over thirty

Table 3. Body length of *T. canis* found in dogs in relation to age and assumed mode of infection (in mm.)

Age group	Dog No.	Body length of <i>T. canis</i>			Remarks
		Prenatal	Undetermined	Postnatal	
5 dy.	{D-9 D-12}	L 2.4-3.8(13) L 2.6-3.1(7)			
10 dy.	D-10	♂ 6.9-9.2(6), ♀ 6.2-11.3(9)			
17 dy.	E-15	♂ 35-58(69), ♀ 40-73(83)		♀ 2.4-3.4(2)	
20 dy.	D-12	♂ 24-37(16), ♀ 39-47(17)		♂ 4.2-7.2(3),	
22 dy.	F-3	♂ 34-59(37), ♀ 41-79(29)			
23 dy.	{F-1 F-2}	♂ 25-52(48), ♀ 50-72(29) ♂ 28-60(43), ♀ 49-75(35)			
26 dy.	E-16	♂ 36-62(58), ♀ 63-105(47)			
30 dy.	{G-6 G-7 G-8 H-7}	♂ 56-70(13), ♀ 67-115(20) ♂ 57-64(5), ♀ 68-92(5) ♂ 61-73(8), ♀ 82-106(13) ♂ 63-78(64), ♀ 82-127(64)	♀ 44 (1) ♀ 41 (1)	♂ 3.4-5.7(7),	♀ 2.7-3.7(4) ♀ 4.1-12.6(6) ♀ 5.9 (1)
35 dy.	{E-7 E-8 E-9 G-2}	♂ 66-84(8), ♀ 106-125(10) ♂ 74-83(3), ♀ 132(2) ♂ 72-77(8), ♀ 120-138(9) ♂ 87(1), ♀ 133-149(6)	♂ 55 (1), ♀ 57 (1), ♀ 34 (1)		
37 dy.	G-1	♂ 82(1), ♀ 138-146(4)			
40 dy.	H-1	♂ 82-98(4), ♀ 128-161(9)			♀ 18.9 (1) ♀ 30, 57 (2) ♀ 9 (1)
42 dy.	{F-4 F-5}	♂ 75-86(6), ♀ 121-157(10) ♂ 76-89(7), ♀ 133-147(4)			♀ 61 (1)
47 dy.	{D-1 D-2 D-3 D-4 D-5 D-6 H-3}	♂ 93, 104(2), ♀ 163(1) ♂ 88(1), ♀ 165-179(4) ♂ 79-91(3), ♀ 158-173(8) ♂ 87-94(9), ♀ 147-185(3) ♀ 121(1) ♂ 74-85(5), ♀ 136(1) ♂ 68-96(11), ♀ 122-162(11)		L 0.6-2.7(23),	♀ 4.3 (1)
50 dy.	{G-4 G-5}	♂ 97(1), ♀ 171(2) ♂ 104(1), ♀ 179(1)			
51 dy.	I-7	♂ 79-90(11), ♀ 133-155(21)	♂ 46-60(2), ♀ 58-96(4)		♀ 24 (1)
56 dy.	{D-7 D-8}	♂ 82-107(4), ♀ 187(1) ♂ 95-107(3), ♀ 132-192(5)			
60 dy.	H-6	♂ 75-87(2), ♀ 121-174(4)		L 1.6-5.4(26),	♀ 5.6-7.8(11) ♀ 8.2-57(5)
4 mo.	{H-4 I-1 I-2 I-3 I-4 I-5}		♂ 126(1), ♀ 87-104(3) ♂ 89(1), ♀ 153(1) ♂ 87-114(3)	L 2.2 (1), L 1.1 (1)	♀ 45 (1)
16 mo.	G-3		♂ 125(1)	L 1.0 (1), L 0.9 (1)	
1½ yr.	{E-11 E-13}		♂ 79-92(3), ♀ 101-146(3) ♀ 125(1) ♀ 105(1)		15 days postparturition 46 days postparturition 21 days postparturition

Note : Numerals in parentheses show number of *T. canis*

days of age, however, a few worms are unable to be decided distinctly whether infecting postnatally or prenatally. The following informations will be deduced from these Tables. 1): The postnatal infection could occur in dogs under four months of age as in Table 4. But its frequency is relatively low under natural conditions, occurring in sixteen of forty-two dogs under four months of age. And also, as shown in Table 3, the number of these

Table 4. The occurrence of *T. canis* in 63 dogs in relation to age and assumed mode of infection

Age group	No. of dogs examined				
	Total	No. of dogs infected			
		Total	Prenatal	Undetermined	Postnatal
5 dy.	2	2	2		
10 dy.	1	1			
17 dy.	1	1	1		1
20 dy.	1	1	1		
22 dy.	1	1	1		
23 dy.	2	2	2		
26 dy.	1	1	1		1
30 dy.	4	4	4	2	3
35 dy.	4	4	4	2	1
37 dy.	1	1	1		
40 dy.	1	1	1		1
42 dy.	2	2	2		2
47 dy.	7	7	7		1
50 dy.	2	2	2		
51 dy.	1	1	1	1	1
56 dy.	2	2	2		
60 dy.	1	1	1		1
3 mo.	1				
4 mo.	7	6		4	4
6-14 mo.	7				
16 mo.-1½ yr.	5	3		3	
2-6 yr.	9				

worms in individual dogs is usually in low levels, calculating only one to six in the majority of the positive cases, with the exceptions of thirteen, twenty-four and forty-four respectively in three dogs. It appears that the number of the postnatally infecting worms is not influenced by that of the prenatal infectors as concerns this examination. 2): As seen from Table 3, it seems that the prenatally infecting worms are generally rather less in numbers in the hosts under thirty days of age than in the olders. This fact may show that the prenatally infecting worms are expelled spontaneously. In fact, the spontaneous elimination of the worm is usually recognized to begin about one month after birth. However, it may be also seen that they are able to remain in the hosts until about two months after birth. In

addition, they seem to obtain the maximum size about fifty to sixty days after the birth of the host. An extremely large male worm is obtained from a dog four months of age. It is uncertain whether this is derived from the prenatal or postnatal infection. 3): As mentioned above, a few worms in twelve dogs over thirty days of age are unable to be determined whether infecting prenatally or postnatally. Of these worms, however, those in three bitches examined from ten to forty-six days postparturition, which are mentioned above, are impossible to be assumed as the prenatal infectors, but rather as the postnatal. This assumption may be able to be applied to the worms, undetermined of the modes of infection, in dogs four months of age, because they are smaller than the prenatally infecting worms found in dogs sixty days of age.

Table 5 shows the number and size of the postnatally infecting worms in various portions of the alimentary canal. It is interesting to note that there are more worms of relatively smaller size (under 1.6-2.7 mm long) in the stomach rather than in the small intestine. This might suggest that the larvae which pass through the trachea and esophagus to the stomach remain and grow in this portion for some times, and then pass to the small intestine. The fact that, in spite of the presence of a few larvae of small size in the stomach, few are present in the small intestine, together with the recovery of a larva from the large intestine of a puppy forty-seven days of age, may suggest the spontaneous elimination of

Table 5. Number and body length of postnatally infecting *T. canis* in various portions of the alimentary canal

Dog No.	Age	Number and body length of the worm						
		Stomach	Small intestine-1	Sm. int.-2	Sm. int.-3	Sm.-int. 4	Cecum	Large intestine
H-7	30 dy.		1 ♂ (5.9)					
H-1	40 dy.		1 ♀ (18.9)					
H-3	47 dy.	22L(0.6-2.7)	1L (1.5)					1 ♀ (4.3)
I-7	51 dy.		1 ♀ (24)					
H-6	60 dy.	4L(0.9-1.6)	22L(1.8-5.4) 6 ♂ (5.8-25) 9 ♀ (5.6-78)	1 ♂ (4.2) 2 ♀ (32-68)				
H-4	4 mo.	1 ♀ (52)	1L(2.2)	3 ♀ (30-57)	1 ♀ (8.2)			
I-1	4 mo.	1L (1.1)						
I-3	4 mo.	1L (1.0)		1 ♀ (45)				
I-4	4 mo.	1L (0.9)						

Note: Numerals in parentheses show body length in mm.

the larvae in feces.

Table 6 shows the days required for the prenatally infecting worms to begin to pass eggs in feces after birth, including the data reported in the previous paper (1954) and newly obtained. The days required are usually in the range of from twenty-one to twenty-three, but in some cases more days are required.

Table 6. Days required for prenatally infecting *T. canis* to begin to pass eggs in feces after birth

Days after birth	21	22	23	24	25	26	27	Total
No. of dogs	5	4	7	1	1	1	1	20

Summary

One hundred and sixty-three dogs, from five days to six years of age, were examined for the occurrence of ascarid, *Toxocara canis*, and the comparison of the body size was performed between these worms and the prenatally infecting worms.

1) Very high occurrences are found in dogs under four months of age, but markedly decrease as grow older, resulting in very low occurrence in dogs over two years of age. However, three of four bitches examined from ten to forty-six days postparturition harbored the worms which were assumed as derived from the postnatal infection.

2) The spontaneous elimination of the prenatally infecting worms appear to begin about one months after birth, but some of them may remain in the host and continue to grow until about fifty to sixty days after birth.

3) The postnatal infection seems to occur until four months after birth.

4) The occurrence of the postnatal infection is rather low under natural conditions, occurring in sixteen of forty-two dogs under four months of age, and in addition, the number of the worms in individual dogs is usually in low level, calculating from one to six in numbers in the majority of positive cases.

5) In dogs over thirty days of age a few worms are difficult to be determined whether infecting prenatally or postnatally.

6) The larvae which pass through the trachea and esophagus may remain and grow in the stomach for some times, and then pass to the small intestine. In addition, the spontaneous elimination of these larvae in feces may occur.

7) The prenatally infecting worms begin to pass eggs in feces from twenty-one to twenty-seven days after birth, but in most cases from twenty-one to twenty-three days.

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