A Contribution to a Knowledge of Canadian Ticks.

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During recent years our knowledge of the biology and distribution of the ticks has greatly increased owing to the discovery of the economic importance of this group as carriers of certain serious diseases to man and domesticated animals. In North America we have the North American Fever Tick *Margaropus annulatus* Say, the well known disseminator of splenitic or Texas fever of cattle, which is credited with an annual loss of about fifty million dollars to the cattle industry of the southern States, and the Rocky Mountain Spotted Fever Tick, *Dermacentor venustus*, the responsible agent for this human disease which has a high rate of mortality.

With the exception of the work of Dr. Seymour Hadwen, Assistant Pathologist of the Health of Animals Branch of the Dominion Department of Agriculture and, to a lesser extent, of myself, no serious attempt has been made to study the ticks occurring in Canada. The present account has been prepared with a view to bringing together the hitherto unpublished results of my own work, and those of Hadwen, together with such scattered references as I have been able to find. It is hoped that this information will constitute a basis for further work, and that the comparative meagreness of the records will stimulate others to add to our knowledge of a group which offers problems of unusual interest.

Except where it is otherwise stated the records in the following account are mine. Hadwen has studied the life-histories of a number of the species and in such cases his results have been given in full or summarized.

Family ARGASIDAE

Ornithodoros megnini Dugres. The Spinose Ear Tick.

(Pl. I, Fig. 1.)

The capture of this species on jack rabbits on October 2, 1912, by Dr. A. Watson at Lethbridge, Alta., is recorded by Hadwen (1913). This is an unusual record, as the tick is generally found on the ears

of cattle horses and dogs and occasionally on man. It has not been recorded previously north of Oregon and Idaho.

Family IXODIDAE

Ixodes angustus Neumann

LOCALITIES.

Jeffrey, N. B. (Coll. C. H. McNutt, x-1908 from a mouse)

Hadwen (1912) gives the following localities: Mount Lehman, B.C., Duncans, B.C.

Banks (1908) gives: Masset, B.C. (Coll. Keen).

Nuttall and Warburton (1911) give: Chilliwack, B.C. (Coll. III-1900).

HOSTS.

Mouse.

Hadwen (*l.c.*) records the following hosts: Squirrels, *Sciurus douglasii* and *S.h. vancouverensis;* rabbit (*L. americanus*); rats and mice.

Nuttall and Warburton (*l.c.*) record a female from *Tamias townsendi*, (Chilliwack, B.C.).

LIFE-HISTORY.

This species was found by Hadwen to occur in all stages on squirrels at Duncans, B.C. These animals appear to be infested with about the same number of ticks throughout the year. During 1910 and 1911 he was able to study its life-history. The male and female ticks were seldom found on the same host and Hadwen believes that copulation takes place almost wholly in the squirrels' nests or on the ground; the restricted movements of the host would not render the latter situation impossible. The following is a summary of Hadwen's observations:

	Average of
Gorged female:	
Oviposition began at	16 days
Larvae hatched at	73 "
Larvae fed on rabbit:	
Average time of feeding	2·5 "
Ecdysis, larvae issue as nymphs	61 "
Nymphs fed on rabbit:	
Average time of feeding	2·5 "
Ecdysis, nymphs issue as adults	29 "
Adults attach and remain for	7 "
Allowance for hardening of skin after ecdysis and	

time in waiting for host, ten days at each stage..... 30 days

221 days

These observations show that it is possible for *I. angustus* to pass through the various stages of its development in seven months.

Ixodes auritulus Neumann

LOCALITY.

Hawden (1914) records the species from Masset, Queen Charlotte Islands, B.C.

HOSTS.

The following hosts in the above locality are recorded by Hawden (*l.c.*):

Queen Charlotte Jay *Cyanocitta stelleri carlottae.*

Alaska Bald Eagle *Haliæetus leucocephalus alascanus.*

It is interesting to note that the previous records of this species (Nuttall and Warburton 1911) are from the Straits of Magellan and Tierra del Fuego, South America, the hosts in both cases being birds.

Ixodes hexagonus Leech

LOCALITY.

Hadwen gives Mount Lehman, B.C. (Coll. 27-I-1911).

HOSTS.

Weasel (Hadwen 1912).

Banks (1908) records the occurrence in Kansas of this species on sheep, with which animals it may have been introduced. He also records specimens from the rabbit. Nuttall and Warburton (1911) record *Sciurus* sp. as a host in California.

Ixodes hexagonus, var. *cookei* Packard

LOCALITIES.

Calabogie, Ont. (Coll. R. M. Reid, v-1908, on dog).

Hadwen collected this species at Mount Lehman, B.C., on dog in 1913.

Banks (1908) gives Guelph, Ont. (Coll. T. D. Jarvis).

HOSTS.

Dog.

This species appears to be identical with the variety *longispinosus* of Neumann (1901) whose specimens were found on the following hosts in the United States: *Lutra*, *Mustela*, sheep (Texas); *Sper-*

mophilus, cat, (Maine); fox, (Colorado); weasel, porcupine and marmot.[1]

Ixodes marxi Banks

LOCALITY.

Banks (1908) gives the following locality: Guelph, Ont. (Coll. T. D. Jarvis).

HOSTS.

Banks states that this species usually occurs on red squirrel, but he also records the fox as a host .

The male of this species has not been described.

Ixodes pratti, Banks

LOCALITY.

Hadwen (1912, 1914) gives the following:

Milk River, Alta. (Coll. A. Watson, VII-1911).

HOSTS.

The following hosts are given by Hadwen (*l.c.*):

Dog and cat (1911).

Horse (1913).

Ixodes ricinus L.
(Pl. I, Fig. 2.)

LOCALITIES.

Specimens have been received from the following localities:

Vancouver, B.C. (Coll. G. W. Boggs, 1907).

Nanaimo, B.C. (Coll. H. Skinner, on dog, 10–VIII–1912).

Hadwen (1912-1914) gives the following localities:

Shawinigan Lake, B.C. (11-XI-1910); Victoria, B.C. (30–VIII–1912); Goldstream, B.C. (1–II–1912); all coll. E. M. Anderson from dog and man. Duncans, B.C. (Coll. S.H. 18–XII–1912) from *Odocoileus columbianum;* Maple Bay, B.C. (Coll. E. M. Anderson, 25–XII–1910; D. Ashby, 19–III–1914; and S.H. 15–XI–1912).

HOSTS.

Dog, man.

Hadwen, (*l.c.*) records:

[1] Since the above was written I have received a specimen of *I. hexagonus* var. *cookei* Pack. through the kindness of Dr. E. M. Walker to whom it was sent by Dr. P. E. Rochon, Clarence Creek, Ont. It was found fixed in the skin of a woman over the right breast where it had been for several months. At first she thought it was a wart on account of its small size when first noticed. It eventually became detached when full grown and engorged and was then noticed by the woman, for the first time, to be alive.

Dog, man and deer (*O. columbianum*).

Nuttall and Warburton (1911), in addition to the above hosts, give records of the following hosts for *I. ricinus* in North America: *Felis concolor*, *Felis pardalis*, *Bos taurus*, *Lepus sylvaticus*, grey fox, wild cat, opossum, ground squirrels and mouse.

Banks (1908) records specimens in the Marx collections from Kansas on sheep and from Texas on cattle and suggests that they were possibly introduced into this continent with their hosts.

Ixodes texanus Banks

LOCALITIES.

Hadwen (1912, 1914) gives:

Mount Lehman, B.C. (Coll. 16–I–1910), and Bella Coola, B.C., Agassiz, B.C. (6–VII–1912).

HOSTS

Hadwen (1912) records the following:

Raccoon (*Procyon lotor*),

Squirrel (*Scuirus h. douglasii*).

Haemaphysalis cinnabarina Koch

(Pl. I, Figs. 3 and 4.)

(SYNONYMY.—Dr. S. Hadwen advises me that Prof. Nuttall in a letter to him states that *Haemaphysalis punctata* C. and F. now becomes *H. cinnabarina* Koch, 1844, as this latter name has priority over *H. chordeilis* Packard. The types are in the Berlin Museum. Neuman placed this species as a synonym of *H. leporis-palustris* but it is of course distinct.)

LOCALITIES

Specimens have been received from the following localities:

Winnipeg, Man. (Received from Vet. Insp. General, coll. on cattle in abattoir, 18–VIII–1913, and 23–IX–1913).

Aweme, Man. (Coll. N. Criddle, 16–VIII–1914, and 5–IX–1914, on cow.)

(Coll. N. Criddle, 2–X–1914 on *Pediœcetes phasianellus campestris* Ridgw.

A larval *Haemaphysalis*, probably *cinnabarina*, was collected by N. Criddle, 24–X–1914 on *Tympanuchus americanus* (Reich.) Ridgw.

Kleena Kleene, Tatla Lake, B.C. (S. H. Colwell, 2–V–1915, on head of rabbit.)

Hadwen (1912, 1914) gives the following locality:

Manitoba (Coll. by J. D. Ross on many occasions).

HOSTS.

Cattle. Sharp-tailed grouse (*Pediœcetes phasianellus* Ridgw.)

Larvae probably of this species from Prairie hen (*Tympanuchus americanus* (Reich.) Ridgw.)

Hunter and Bishopp (1910) state that this species has been recorded as causing the death of young turkeys in Vermont.

Haemaphysalis expositicius Koch.

One lot of engorged females of this species has been received from Winnipeg, Man., September, 1911.

Haemaphysalis leporis-palustris Packard. The Rabbit Tick.

LOCALITIES.

Specimens were collected by me at Aweme, Man. 15–IX–1913 on rabbit. This species has also been received from Jeffrey Corner, Kings Co., N.B. (Coll. C. H. McNutt, 20–VI–1911).

Hadwen (1912, 1914) gives the following localities:

Aweme, Man.; Prince Albert, Sask. (Coll. F. Torrance 8–VI–1914); Mount Lehman, B.C.; Agassiz, B.C., Nelson, B.C., Peardonville, B.C.

HOSTS.

Rabbit (*Lepus americanus*).

Banks (1908) states that the young ticks are taken upon such ground inhabiting birds as quail, lark, etc.

LIFE CYCLE.

Hadwen (1912) gives the following notes on the life cycle:

Engorged females collected	Oviposition began	Eggs hatched
May 13, 1910.	June 1, 1910.	July 18, 1910.
May 17, 1910.	May 25, 1910.	Did not hatch.
July 17, 1911.	July 23, 1911.	Sept. 6, 1911.

The larvæ from the last experiment were still alive on February 9, 1912. They were placed on a tame rabbit April 12, 1912, and the gorged larvæ came off the rabbit from April 17 to April 19. Twelve gorged nymphs were taken from rabbit (Coll. N. Criddle, Aweme, Man.), July 17, 1911; 4 hatched August 15, 1911. 32 nymphs collected off rabbit (Aweme, Man.), July 17, 1911, were placed on a tame rabbit. On July 29 or 30 four were gorged; two hatched September 21, 1911, and one hatched September 26, 1911.

On May 18, 1912, Hadwen (1914) collected 87 males and 21 females off rabbit. This record indicates that the sexes copulate

on the host, as no copulation was observed when the ticks were afterwards kept together in a large glass container.

This tick is one of the most widely distributed species. Hunter and Bishopp (1910) state that the U.S. Bureau of Entomology has a record of 1,033 ticks of this species having been taken on two rabibts in western Montana. I have found them almost equally abundant on rabbits in Manitoba. They are usually attached about the rabbit's ears and head and their numbers may be sufficiently great to weaken the host and render its capture by other animals more easy.

Amblyomma americanum L. The Lone Star Tick.

LOCALITY.

Aweme, Man.

The capture of this species by Mr. Norman Criddle in the above locality in southern Manitoba as recorded by Hadwen (1912) is of interest as it had not been collected north of Illinois and Michigan on the central part of the continent according to the distribution map of Hooker, Bishopp and Wood (1912), who also state that the Marx collection contains one unengorged female from Labrador.

Dermacentor albipictus Packard.
(Pl. II, Figs. 5 and 6).

LOCALITIES.

Specimens have been received from the following localities:

Peniac (York Co.) N.B. (Coll. W. Wade, on horse, 15–v–1915).

Hudson Heights, Que. (Coll. A. E. Moore, 21–IV–1911, on elk imported from Wyoming.)

Riding Mountains, Man. 4–XII–1911, on moose.

Windermere, B.C. (Coll. E. D. Ellis, 8–IV–1913).

Gateway, B.C. (Coll. K. R. Foster, 13–II–1912, on horses from Montana).

Okanagan Falls, B.C. (Coll. Parham Bros, 13–IV–1915).

Huntingdon, B.C. (Coll. Vet. Inspect. Ransom, 15–IV–1911).

Crawford Bay, B.C. (Coll. W. W. Mooney, 22–I–1912).

Hadwen (1912) gives the following localities:

Huntingdon, B.C.; Peardonville (Vancouver Island), B.C., Lilloet, B.C.

The type specimens in the Museum of Comparative Zoology, Cambridge, Mass., are from Nova Scotia and were taken from Moose.

HOSTS.

The following hosts have been recorded:

Moose, elk and horse.

Hadwen (1912) records:

Cattle, horse, mule and deer (*Odocoileus hemionus* and *O. columbianum*).

This is a common species throughout the northern United States and its distribution covers the breadth of Canada. The capture at Hudson Heights, Que. (near Montreal) of specimens on elk imported from the state of Wyoming is an indication of the possibilities of artificial dissemination. These elks were imported in the fall of 1910 and were one year old.

This species of tick does not drop off its host to moult. The records of capture indicate that it is found on the host animals chiefly during the winter and spring months. It is the chief "wood tick" of the early spring.

Dermacentor albipictus is not generally considered to be a tick of economic importance, but that this may be an incorrect attitude to assume towards the species is indicated by the following statement made by Bishopp and Wood (1913) in discussing its economic importance: "During these investigations we have found the tick to be an important pest of horses and cattle during the autumn, winter and early spring. The tick is much more severe on horses than cattle, mainly owing to the preference shown for the former animal as a host. Reports have been received from California, Montana and Oregon, stating that horses and colts become very weak and that colts not infrequently succumb if the ticks are not promptly killed. During the spring, in territory infested by the Rocky Mountain Spotted Fever tick (*Dermacentor venustus*), the combined attack of these two species, together with a shortage of feed, often causes the death of numbers of horses where they are not properly cared for."

SUMMARY OF LIFE-HISTORY.

The non-parasitic portion of the life-history commences in the spring when the engorged fertilised female drops off the host to oviposit. Detached females forwarded to me from British Columbia in 1911 commenced to oviposit indoors in April, each female depositing from 3,000 to 5,000 eggs during the succeeding months of May and

June.[1] The larvae began to emerge in July. Bishopp and Wood (*l.c.*) found the pre-oviposition period ranged from 7 to 134 days, the incubation period from 33 to 71 days and the longevity of the larvae from 50 to at least 346 days. The combined periods from the dropping off from the host of the engorged females to the death of the last larva, or the whole non-parasitic period, ranges normally from 159 to at least 479 days. The larvae attach themselves to their host during the autumn, winter and spring months.

Dermacentor variabilis Say

LOCALITIES.

Banks (1908) states "specimens come from many places in the Eastern United States, from Labrador to Florida and Texas."

Hadwen (1912) received specimens from Aweme, Man. (Coll. N. Criddle, 2–VI–1910).

HOSTS.

Hadwen (*l.c.* and 1913) records its occurrence on the following hosts:

Dog, cattle, horses, man.

Banks (*l.c.*) states that it has been taken from a great variety of animals including man, but that it seems to prefer dogs and cattle to smaller animals, which he suggests is due to the fact that the freshly moulted individuals climb up several feet from the ground in wait for a host.

SEASONAL HISTORY AND LIFE CYCLE.

From 1910 to 1912 Hadwen (1912 and 1913) attempted to rear this species through its various stages on tame rabbits and succeeded in 1911 and 1912. In Manitoba most of the engorged females were collected in June; the earliest specimen was captured (by Mr. Norman Criddle at Aweme, Man.) on May 25th and the latest on July 17th. As soon as the warm weather follows the disappearance of the snow the adults are found everywhere and are very annoying to man and beast. As in the case of *D. albipictus* and *D. venustus* the partly engorged females are remarkably tenacious of life in comparison with the fully gorged and ungorged females.

[1]Misfortune constantly attended my life-history experiments, on this species and *D. venustus*. In the summer of 1910 detailed notes of the life-history studies of *D. albipictus* were lost during my absence, having apparently been swept off my table into a waste-paper basket; perhaps fate was a more able judge than I of their worth! When similar studies were being made in 1912 of *D. venustus* the carelessness of an unknown person caused the wholesale escape of ticks in my room and necessitated the closing down of the experiment.

D. variabilis is a three-host tick. The life cycle appears to start in the spring with the adult female and to be carried as far as the nymphal moult during the summer and autumn and the winter is probably passed in this stage, the adults emerging in the spring. Under laboratory conditions Hadwen found that about 210 days were required for adults to issue, reckoning from the time when the gorged mother tick abandoned the host, and without taking into account the variable period of time which the tick may have to wait for a host when unfed.

Hadwen (1912) found that the females oviposited at the following times:

Engorged females collected	Oviposition began	Eggs hatched
June 2, 1910	June 18, 1910	Aug. 8, 1910.
" 19, "	July 1–4, "	" 21, "
" 19, "	" 1–4, "	" 22, "
May 25, 1911	June 22, 1911	Eggs not hatched.
June 25, "	July 5, "	Aug. 26, 1911,
July 6, "	" 16, "	" " "
" 6, "	" 16, "	" " "

The complete life cycle of the last mentioned specimens was obtained under laboratory conditions and was as follows:

Engorged ♀ from dog	July 6, 1911				
Oviposition began	July 16, 1911	Average number of days			10
Eggs hatched	Aug 26, 1911	"	"	"	" 41
Larva placed on rabbit	Feb. 10, 1912				
Came off gorged	Feb. 13–16, 1912	"	"	"	" 4½
Larvae moulted and nymphs emerged	Apr. 30 to May 13, 1912	"	"	"	" 84
Nymphs put on rabbit	May 9-13, 1912				
Came off gorged	May 14-20, 1912	"	"	"	" 6
Adults emerged	June 20–27, 1912	"	"	"	" 35
					180½

Dermacentor venustus Banks. The Rocky Mountain Spotted Fever Tick.

(Pl. II, Figs. 7 and 8; Pl. III, Figs. 9 to 12).

In view of the possible occurrence of Rocky Mountain spotted fever in Canada, and the fact that with the exception of a single recorded capture of *D. venustus* at Kaslo, B.C., no knowledge was available at that time concerning the distribution of this tick in Canada, an investigation was commenced by me in 1911. The Veterinary Director General of the Department of Agriculture, Dr. J. G. Rutherford, C.M.G., most kindly assisted me by sending to all

the Veterinary Inspectors of the Department in western Canada a letter that I drafted requesting specimens of ticks. I also sent the same letter to Farmers' Institutes in British Columbia and Alberta and others who might be able to assist. These requests resulted in the receipt not only of specimens of *D. venustus* but of other species also. In this matter Mr. J. W. Cockle of Kaslo, B.C., was particularly active and helpful, for which assistance I am extremely grateful. The result of this inquiry which is now given showed that *D. venustus* is generally distributed throughout southeastern British Columbia and in the adjacent portion of Southern Alberta. The greatest number of records were received from the Kootenay region. Further studies would no doubt extend the known area of distribution.

LOCALITIES.

Specimens were received from the following localities:

Bridesville, B.C. (Coll. W. Thompson, 17–IV–1912).

Keremeos, B.C. (Coll. W. Thompson, 29–V–1912, on horses imported from the state of Washington and proceeding to the Peace River district, Alta., also collected 10–VI–1912).

Ymir, B.C. (Coll. J. W. Cockle, IV–1912).

Kaslo, B.C. (Coll. J. W. Cockle, 6–V–1912).

Crawford Bay, B.C. (Coll. W. W. Mooney, 6, IV. 1912).

Cranbrook, B.C. (Coll. J. H. McClure, 6–V–1912 at 3,500 feet altitude, attached to a woman's arm; also coll. S. MacDonald, 19–VI–1912).

Wattsburg, B.C. (Coll. Miss Watts, 16–V–1912).

Penticton, B.C. (IV–1910).

Nelson, B.C. (Coll. J. W. Frank, VI–1912; also coll. J. W. Cockle, 15–V–1912).

Pincher Creek, Alta. (Sent by D. Warnock, 5,000 ft. altitude).

Hadwen (1912) has also recorded this species from the following localities:

Kaslo, B.C.; Pilot Bay, B.C.; Osoyoos, B.C.; Merritt, B.C.; Huntingdon, B.C., and Treesbank, Manitoba, where it was collected by N. Criddle.)

HOSTS.

The specimens received by me had been taken from the following hosts:

Horse, man, grizzly bear and mountain sheep.

Hadwen (1912) records the following hosts:

Cattle, horses, man, rabbit and squirrel.

NOTES ON DISTRIBUTION OF *D. venustus.*

The frequent capture by the veterinary inspectors of the Department of Agriculture of this species on horses imported into Canada from the infested states to the south of the international boundary indicates a common means of introduction of this species into distant localities in which it may not already occur. Nor is the possibility of the introduction of infected ticks too remote to be refused consideration.

The following notes have been selected from the letters accompanying specimens of *D. venustus:*

"These ticks produce intense irritation and cause those affected to break out in pimples. They are very plentiful all through that district (Ymir, B.C., which is south of Nelson, B.C.) as many as sixty having been removed from the clothing and person of one man after a tramp through the bush. There appears to be no bad fever resulting from this infection." (J. W. Cockle).

Miss Watts (Wattsburg, B.C.) found the specimens in climbing a mountain and reported that they were rather numerous in 1912, especially near cedar woods.

S. MacDonald, when sending *D. venustus* from Cranbrook, B.C., wrote: "I am sending you . . . what is known as 'Wood Tick.' From inquiries several people claim them to be a cause of blood-poisoning, while some even claim they cause spinal meningitis. I can give you a little experience of my own. One got on my boy ten years old and bit him about six inches below the neck, two inches from the spinal centre; it had penetrated under the skin and looked like a blister. I raised the body inserting coal oil which caused it to come out. The common theory is that you cannot pull them out without leaving a part of the head in, which causes the poisoning".

Dr. Warnock sent specimens some of which were taken from a horse about twenty-five miles south-west of Pincher Creek, Alta. Of other specimens he wrote: "The others, Mr. Riviere, Game Guardian, picked from his clothes while patrolling the mountains. Mr. Riviere informs me he could get many from mountain sheep, goat and deer were it not close season." This was in July, 1912.

J. H. McClure wrote (July 28th, 1912), "A young lady who works for us took this one off her arm. It was hard at work and was removed with difficulty."

ECONOMIC IMPORTANCE OF *D. venustus.*

Inasmuch as this species is responsible for the transmission of the disease known as Rocky Mountain spotted fever which has a high percentage of mortality in the northwestern United States, particularly in the Bitter Root Valley of the State of Montana, its

presence in western Canada and the danger of the introduction of infected ticks on mammals are questions of no little importance. So far as my own inquiries are concerned no evidence has been obtained of the presence in Canada of any cases of this disease. Since 1912, however, reports have been received of the occurrence of the bites of this species causing petechial outbreaks on the body and paralytic symptoms in children.[1] Hadwen (1913) reported the occurrence of "Tick Paralysis" in sheep in British Columbia. The occurrence of this paralysis in man was investigated by Todd, who published a preliminary account of the results of his enquiry in 1912. In 1914 Todd communicated to this Society a more complete account of his inquiries and of experiments which he had carried on, which account he has since published and it constitutes the most complete record we have of this peculiar trouble. Nuttall (1914) has also collected further records. These papers bring together practically all the evidence regarding the occurrence of paralytic symptoms in man, sheep and dogs resulting from the bites of this species and this evidence therefore need not be reviewed here. The evidence shows that more than one species of tick may produce these paralytic symptoms and that *D. venustus* is able to produce paralysis in lambs and in a puppy under laboratory conditions. A case was brought to my notice of the production of temporary paralysis in a child in Nelson, B.C., by *D. venustus* from which paralysis the child recovered, as is usually the case, after the removal of the tick which was attached to the back of the neck. This temporary paralysis which is reported to prove fatal if the tick is not removed, is distinct from the paralysis characteristic of acute poliomyelitis.

SUMMARY OF LIFE CYCLE OF *D. venustus*.

Experiments of the life-history of this species were begun in 1912 but an accident in my laboratory and absence in England prevented any satisfactory progress being made beyond obtaining data on the oviposition and length of egg stage. Fertile eggs, however, were forwarded to Prof. Nuttall who succeeded in rearing the adults (see Nuttall, 1915). The following account is based on the investigations of Hadwen (1913), Hunter and Bishopp (1911) and Nuttall (*l.c.*) and my own fragmentary records:

Dermacentor venustus requires three hosts upon which to feed in the larval or nymphal and adult stages. These stages remain on

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[1]Ann. Rep. Dominion Entomologist, Year ending March 31, 1913, in Rept. Dominion Experimental Farms, Dept. Agriculture, Ottawa, p. 512.

the host for the following periods: Larva, 2–8 days; nymph, 4–11 days; the adult female feeds from 5–15 days, the male feeds from 3–4 days before seeking the female. *Metamorphosis* from egg to larva lasts in Montana from 14–25 days; from larva to nymph in British Columbia 24–38 days; from nymph to adult from a minimum of 12 days to a maximum of 170 days in Montana, or 32 days in summer and 84–94 days in winter in British Columbia. *Oviposition*, reckoned from the day the female abandons the host, begins in Montana 6–13 days in warm weather and 41 days when it is cool. The female may survive 1–14 days after the eggs are laid. The number of eggs laid by one female may vary from 2,500 to 7,140, 4,000 being about the usual number. *Longevity*. Unfed larval ticks usually die in 30 days, but they may survive up to 117 days; unfed nymphs may live over 300 days; adults captured in the spring on vegetation survived unfed for 413 days, after fasting for 365 days they readily attached themselves to a host. The life cycle may be completed in 68 days under most favourable conditions; the time usually required is 2 years, but 3 years may be required. The *seasonal history* in Montana is as follows: the unfed nymphs and adults hibernate; they find hosts from March to July, during which time they attack man; the females which feed in the spring lay eggs which lead to adults in September. Nymphs occur on small wild mammals in March to July inclusive. These individuals hibernate as unfed adults. The adults occur on large wild and domesticated animals and on man, but the immature stages rarely if ever occur on other than small animals.

Literature.

The following list contains certain works additional to those referred to in the text with a view to assisting those desiring further information on North American ticks.

Banks, N. A Revision of the Ixodoidea or Ticks of the United States. U. S. Dept. Agriculture, Bur. Ent., Tech. Ser. Bull. No. 15, 61 pp., 10 pls. 1908.

Bishopp, F. C. and H. P. Wood. The Biology of Some North American Ticks of the Genus *Dermacentor*. Parasitology. Vol. 6, pp. 153-187, 1 fig., 3, pls., 1913.

Hadwen, S. On "Tick Paralysis" in Sheep and Man following bites of *Dermacentor venustus*, with notes on the Biology of the Tick." Parasitology, Vol. 6, No. 3, pp. 283-297. October, 1913.

Hadwen, S. and Nuttall, G. H. F. Experimental "Tick Paralysis" on the Dog. Parasitology, Vol. 6, No. 3, pp. 298-301, Oct. 1913.

Hadwen, S. Reports of the Veterinary Director General, Department of Agriculture, Ottawa, Canada, for the Years ending March 31st, 1912, 1913 and 1914 respectively. In Report for 1912, see pp. 93-99; in Report for 1913, see p. 80.

Hewitt, C. G. Reports of the Dominion Entomologist, Department of Agriculture, Ottawa, Canada, for the Years ending March 31st, 1911 (pp. 225-226); 1912 (p. 183); 1913 (p. 512.)

Hooker, W. A., Bishopp, F. C., and Wood, H. P. The Life-History and Bionomics of some North American Ticks, U. S. Dept. Agric., Bur. Ent., Bull. No. 106, 239 pp., 17 figs., 15 pls., 1912.

Hunter, W. D., and Bishopp, F. C. The Rocky Mountain Spotted Fever Tick, with special reference to the problem of its control in the Bitter Root Valley in Montana. U. S. Dept. Agric., Bur. Ent., Bull. No. 105, 47 pp., 3 pls., 3 figs 1911.

Nuttall, G. H. F. "Tick Paralysis" in Man and Animals. Further published records with comments. Parasitology, Vol. 7, No. 1, pp. 95-104, May, 1914.

Nuttall, G. H. F. Observations on the Biology of Ixodidae, Part II. Parasitology, Vol. 7, No. 4, pp. 408-456, March, 1915.

Nuttall, G. H. F. and Warburton, C. Ticks. A monograph of the Ixodidae. Part I. Argasidae. pp. 1-104, 144 figs., pls. I-III. 1908. Part II. Ixodidae. pp. 105-348, figs. 115-307. Pls. IV-VII. 1911.

Todd, J. L. Tick Bite in British Columbia. Canadian Medical Assn. Journ., Dec., 1912. (Reprint, 2 pp.)

Todd, J. L. Tick Paralysis. Journ. Parasitology, vol. 1, pp. 55-64, Dec. 1914.

ILLUSTRATIONS.

Map showing the Distribution of the Rocky Mountain Spotted Fever Tick *Dermacentor venustus* in western Canada as recorded up to May, 1915.

PLATE I.

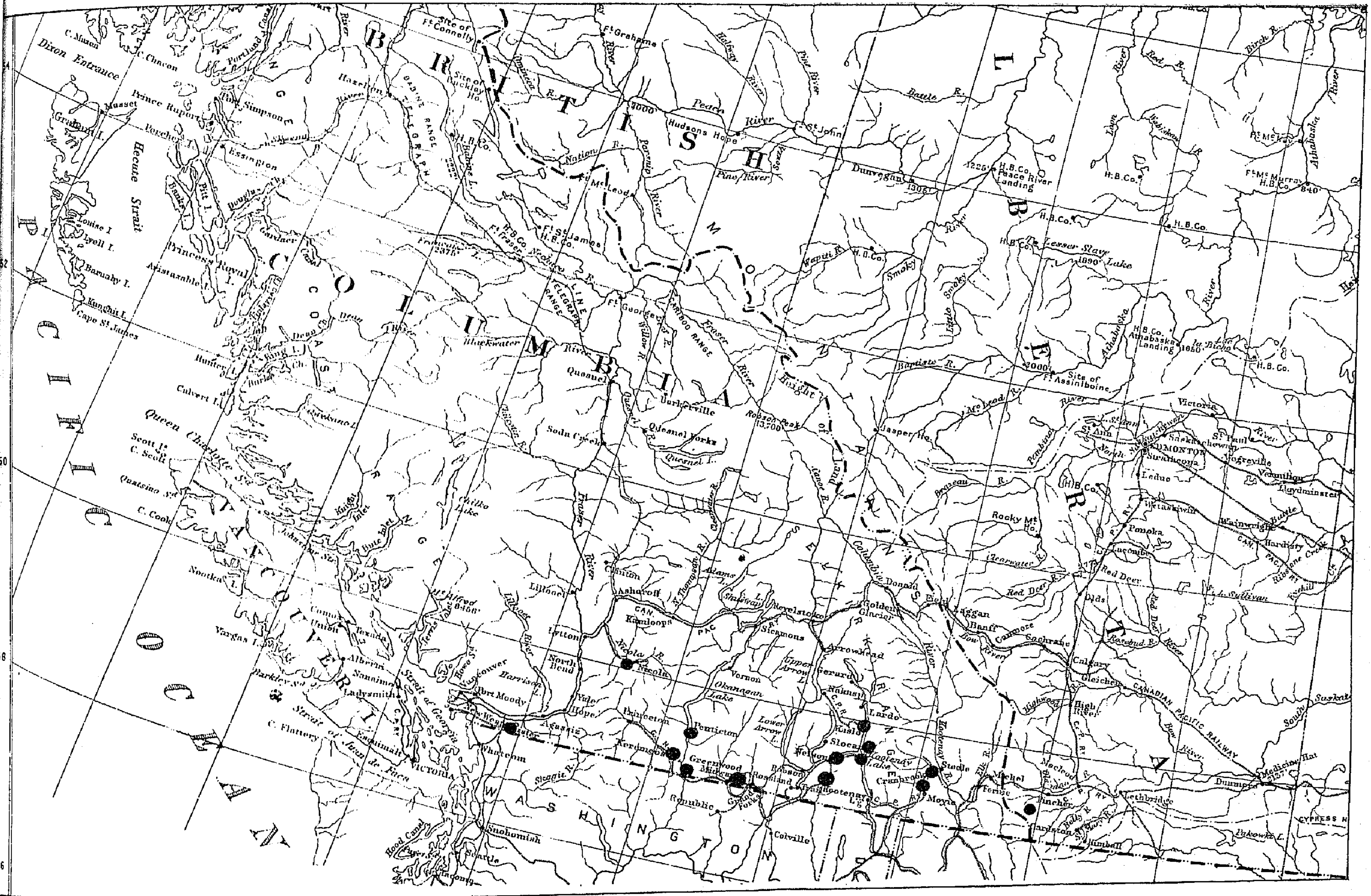
Fig. 1. *Ornithoderos megnini.* Dorsal aspect.
Fig. 2. *Ixodes ricinus.* Engorged female; dorsal aspect.
Fig. 3. *Haemaphysalis cinnabarina.* Engorged female; dorsal aspect.
Fig. 4. *H. cinnabarina.* Engorged female still attached.

PLATE II.

Fig. 5. *Dermacentor albipictus.* Engorged female; dorsal aspect.
Fig. 6. *D. albipictus.* Male; dorsal aspect.
Fig. 7. *Dermacentor venustus.* Engorged female; dorsal aspect.
Fig. 8. *D. venustus.* Engorged female; ventral aspect.

PLATE III.

Fig. 9. *Dermacentor venustus.* Unengorged female; dorsal aspect.
Fig. 10. *D. venustus.* Unengorged female; ventral aspect.
Fig. 11. *D. venustus.* Male; dorsal aspect.
Fig. 12. *D. venustus.* Male; ventral aspect.



Distribution of Rocky Mountain Spotted Fever Tick (*Dermacentor venustus*) in Western Canada as recorded up to May 1915.

PLATE I

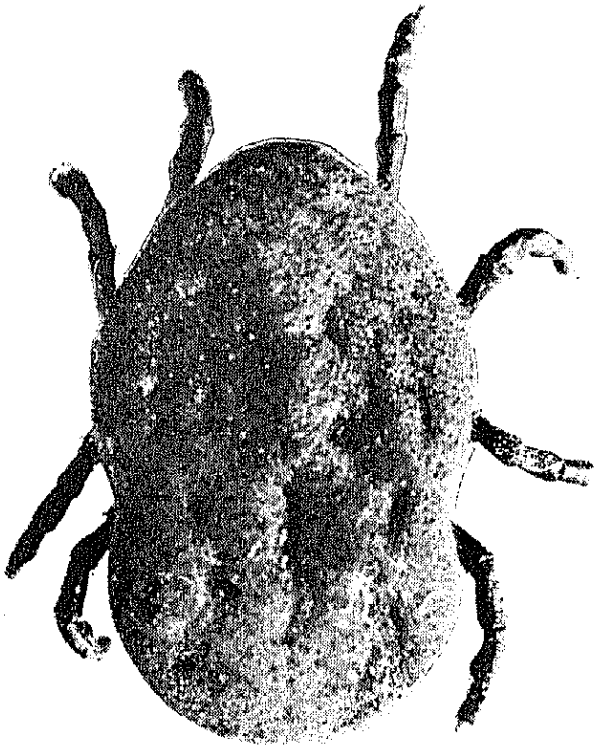


Fig. 1

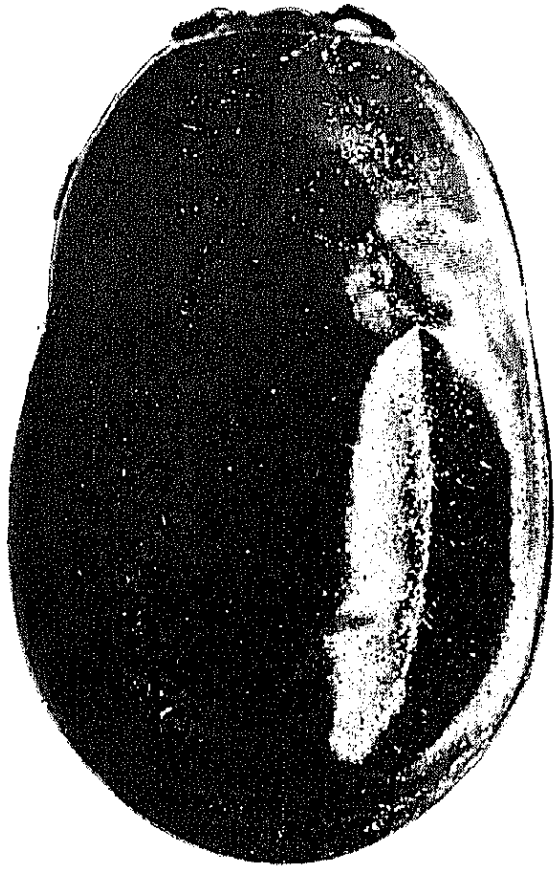
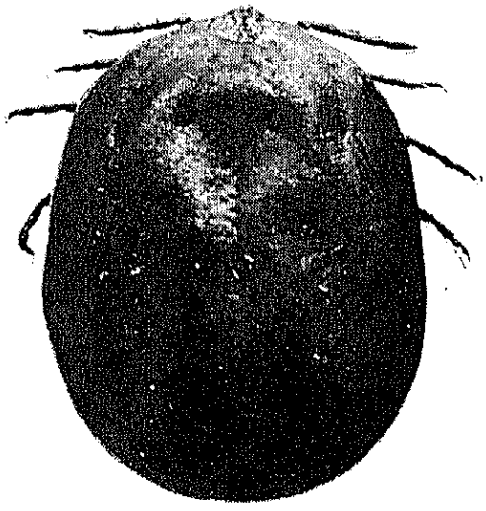


Fig. 2



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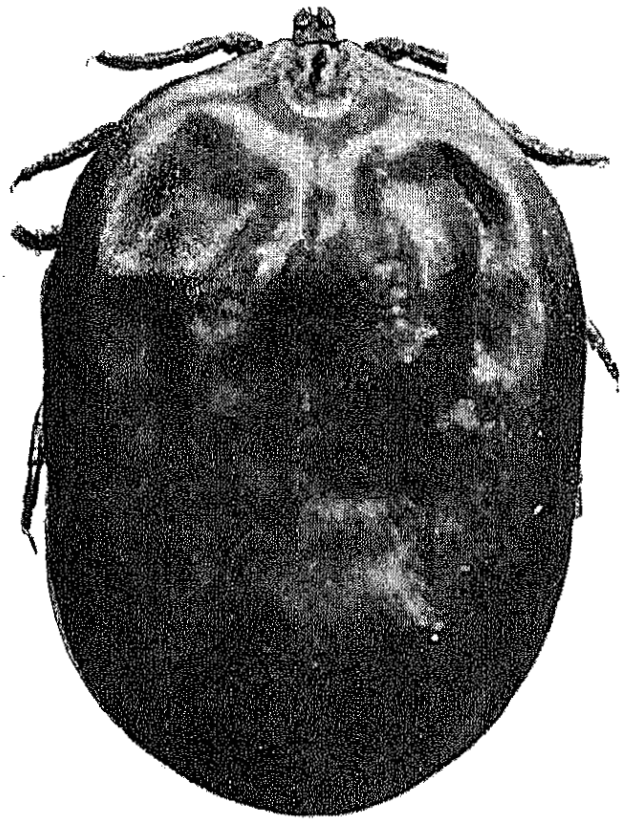

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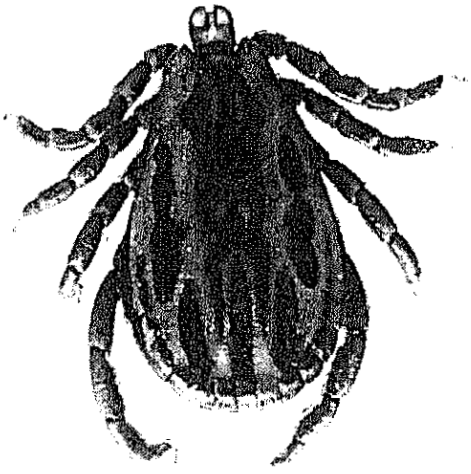

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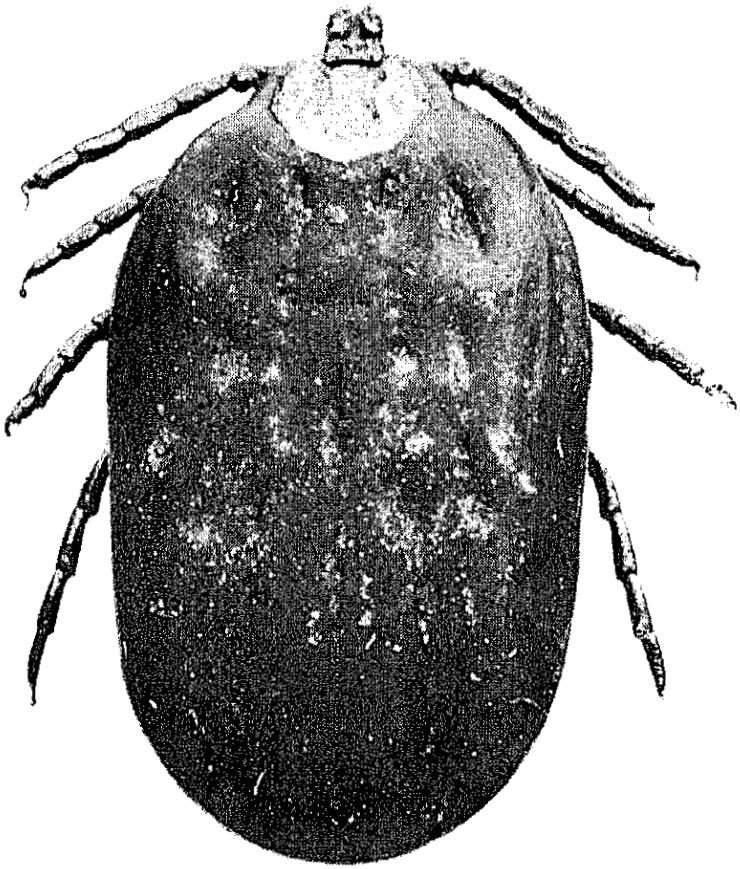

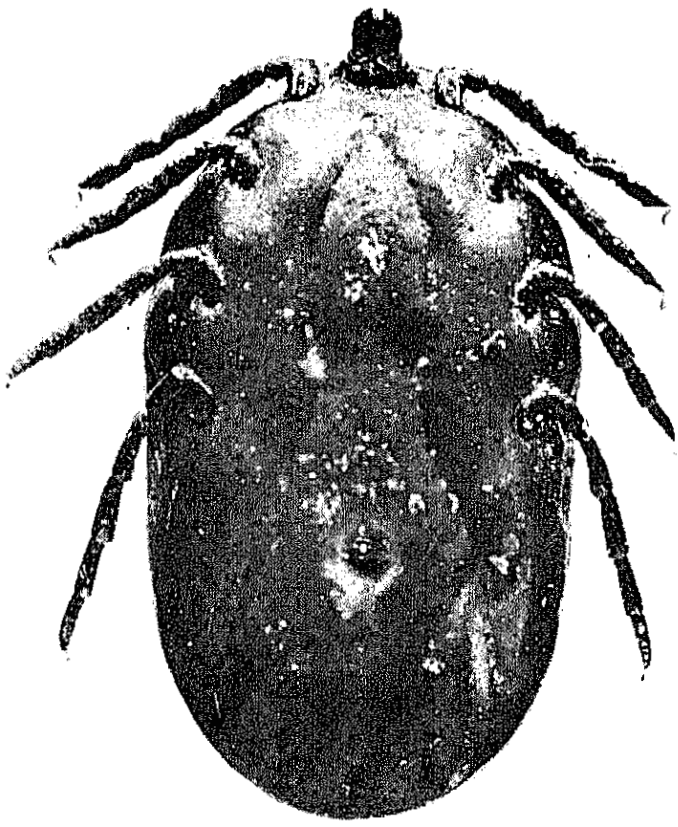

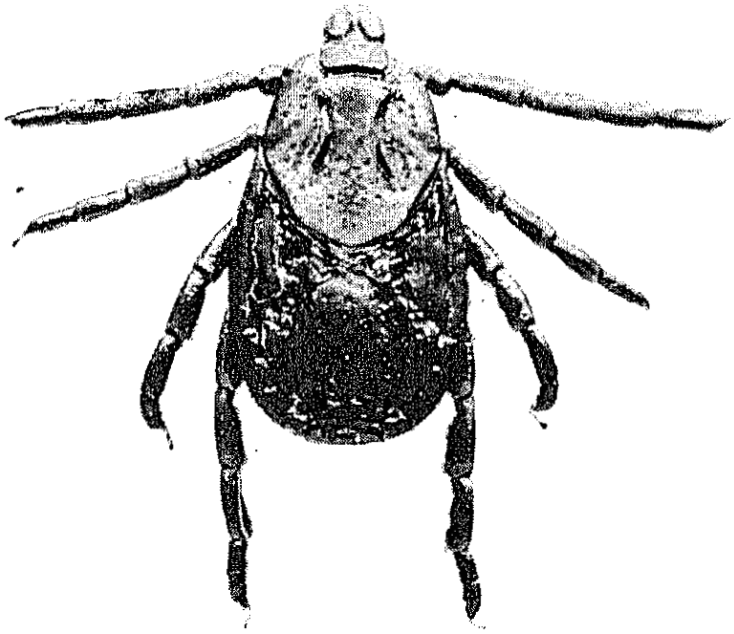

Fig. 9

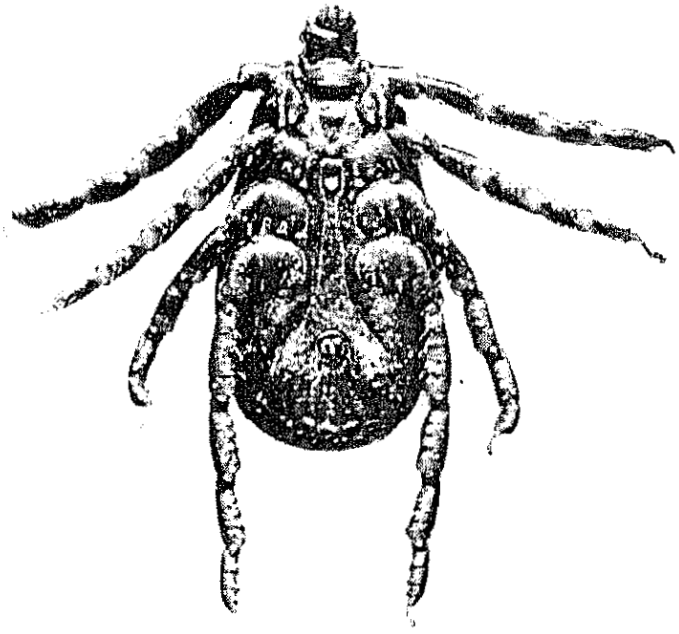

Fig. 10

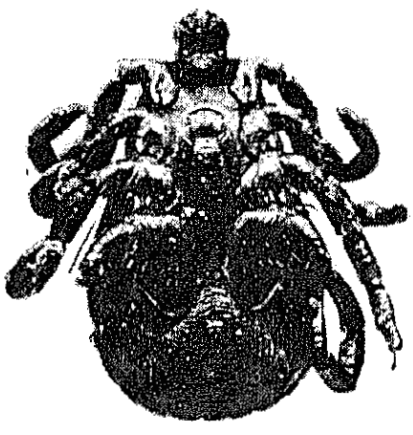

Fig. 11

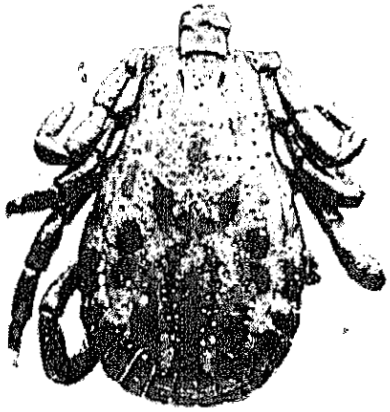

Fig. 12