NOTES ON THE CAT FLEA (*CTENOCEPHALUS FELIS* BOUCHÉ).[1]

By Harold Lyon.

The following observations were made in connection with some attempts during the past winter to devise a satisfactory method for the propagation of fleas to be used for experimental purposes. It had been intended to make use of the reared insects for experiments concerning their possible association with anterior poliomyelitis (infantile paralysis), but as it was not possible to secure proper facilities for this work at that time, it has seemed advisable to publish earlier some of the observations.

These relate primarily to the seasonal abundance of the cat flea, since it is difficult to obtain from existing literature any adequate data upon the relative abundance of fleas during the various months of the year, in regions where there is a considerable annual range of temperatures. The association between bubonic plague and various fleas, particularly the tropical rat flea (*Xenopsylla cheopis*) has long been known as well as the rôle of *Ceratophyllus fasciatus* in transmitting plague in the more temperate regions of the northern hemisphere. However, most of the work on plague and fleas has been done in the tropics or subtropics and the careful data collected in such climates cannot be applied to the conditions which exist in our own region. Observations on the seasonal prevalance of *Ceratophyllus fasciatus* have been made notably in England by Nuttall and also in California by Mitzmain, but none seemed sufficient for the present purpose. It was therefore determined to make a uniform series of counts of the number of fleas occurring on cats in the city of Boston from week to week during as long a period as possible. With the kind permission of Mr. Huntington Smith of the Animal Rescue League, it was possible to examine the cats collected by the officers of the league and these examinations have formed the basis for the accompanying tabulations. The data on seasonal distribution begin with December 1914 and have continued to the present date of writing.

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[1] Contributions from the Entomological Laboratory of the Bussey Institution, Harvard University, No. 96.

Soon after the animals had been killed, their fur was carefully gone over with a fine-toothed comb and the fleas present on each were counted. As the time was limited, five cats were chosen as a unit. These were selected at random and the lot contained both homeless and strayed pet cats. The extent of infestation varied greatly, but contrary to expectations seemed to be as great in the pets as in the homeless ones. No doubt, more fleas could have been obtained from individual cats if it had been possible to examine each animal exhaustively, but as all were gone over with the same thoroughness, the conclusions as to the comparative abundance can be regarded as trustworthy.

The data obtained have been summarized in the following table:

Number of animals examined	139
Number of animals with fleas	114
Number of animals without fleas	25
Total number of fleas	590
Greatest number per cat	30
Smallest number per cat	1
Average number per cat	4.24

Monthly Average per Cat.

December	3.75
January	3.85
February	2.3
March	1.08
April	2.52
May	3.1
June	3.98
July	10.05

A number of very interesting facts are brought out in the table, and some are rather different from what had been anticipated. It is, of course, common experience that fleas are less abundant in the winter than in the summer, but so great a variation had not been expected, since the adult insects would not seem to be greatly affected by temperature, living as external parasites of a warm blooded animal. The larvæ are, of course, subjected to a much greater range of temperature, as they live in the nest of the animals which they infest or in accumulations of dust and animal refuse nearby. This probably accounts for the late appearance of considerable numbers of fleas in the spring, while their persistence well into the winter may be due to the continued warm environ-

ment of the adults on the body of their host after the onset of cold weather.

Some years ago Conn of the Connecticut State Board of Health (*Rept. State Bd. Health,* Conn., 1910–11 (1912) suggested a possible etiological connection between fleas and anterior poliomyelitis, but others have not been able to harmonize the persistence of fleas through the winter with the very slight incidence of poliomyelitis during this part of the year. Thus, in considering any possible insect carriers of this disease, Brues and Sheppard (*Journ.*

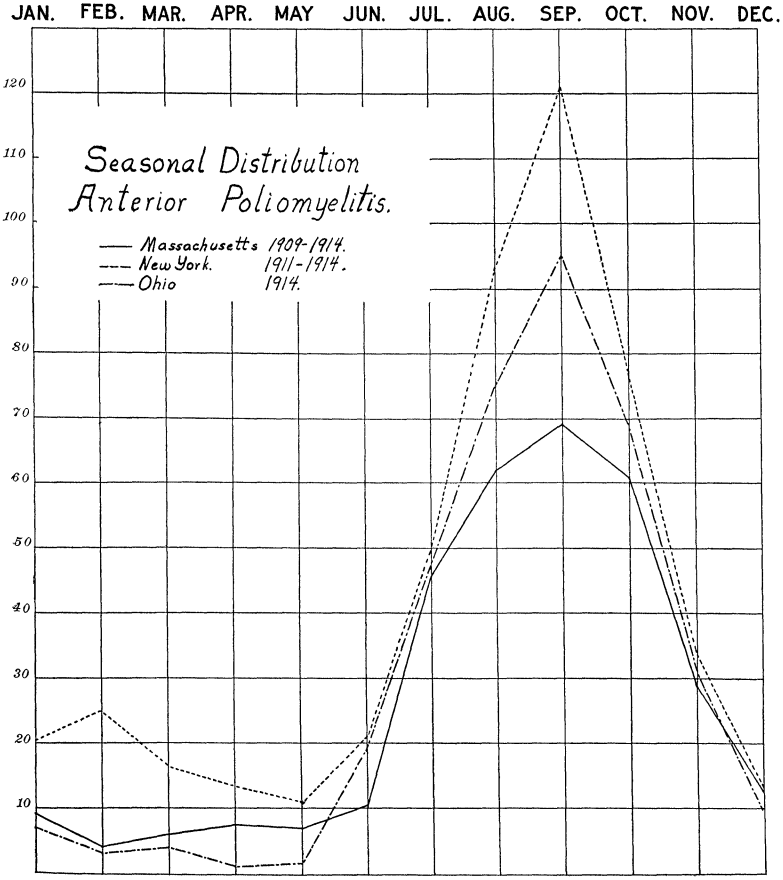


Table 1. Seasonal Incidence of Anterior Poliomyelitis in Massachusetts, New York and Ohio.

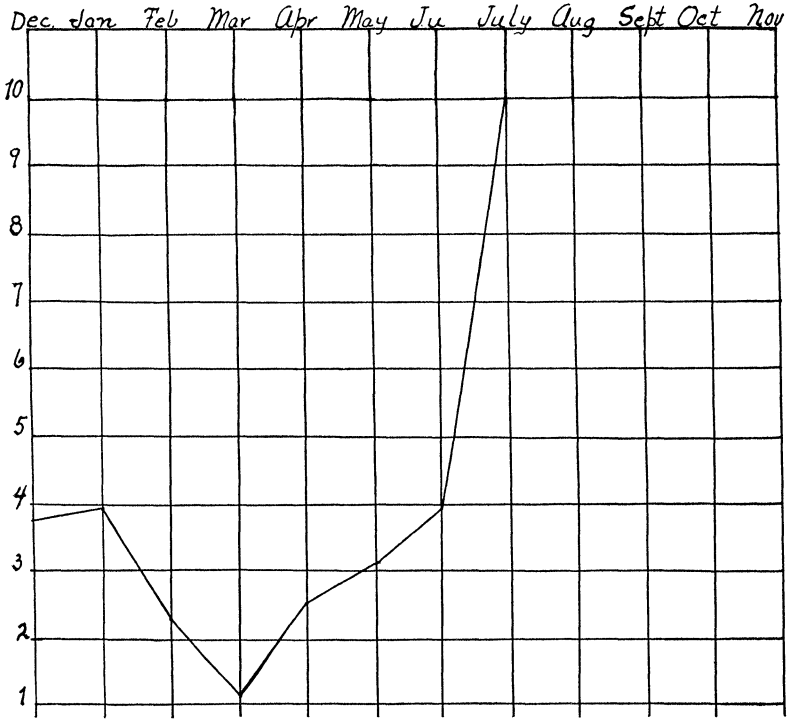


Table 2. Seasonal Abundance of the Cat Flea (*Ctenocephalus felis*).

Econ., Ent., Vol. 5, p. 314 (1912) were led to disregard fleas for this reason. The present data show, however, that in a climate like that of New England the seasonal prevalence of these insects agrees, in some respects at least, quite well with the seasonal incidence of the disease. The relationship which exists is shown graphically in the following tables (Tables I and II), in which are observed the abundance of the cat flea and the reported incidence of poliomyelitis. The data concerning the disease have been collected from a number of sources and relate to several states so as to minimize, as far as possible, any irregularities which might arise from the small numbers of cases reported during the winter months.

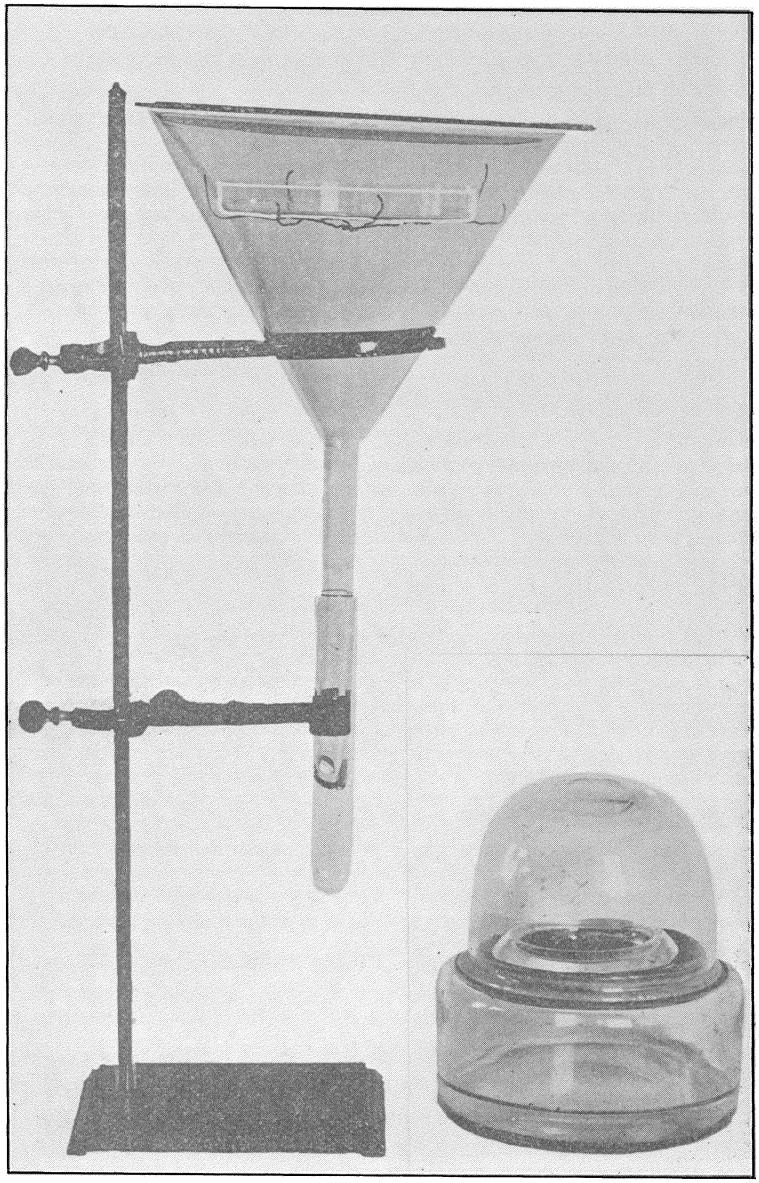
In the reports of the Massachusetts State Board of Health on Infantile Paralysis for the years 1907–1912, we find the following

information bearing directly on the question. As the majority of the domesticated animals may harbor fleas of various species, we find that in 1909–10 out of 328 families where the disease was reported, there were no animals present in 131 cases, that there were animals present in 197 cases and that 125 animals had sickness or death in 70 of the families. In this instance there were animals present in 60 per cent. of the families. Again in a later report we find that "out of 186 families in which acute epidemic poliomyelitis occurred, 34 homes had illness, paralysis or death in 82 animals. One hundred and ten of the families above mentioned had animals; therefore, about thirty per cent. of 110 families with animals, had paralysis or death in their animals." All animals in this case except two may bear fleas. Again, out of 33 cases, all of which had animals present, there were 28 cats and dogs in the home. It was also reported that out of 328 families where vermin, insects, rodents, etc., were present, there were 224 with rodents, which are common hosts of fleas.

Method of Raising Fleas.

The adult fleas after each combing were brought to the laboratory and various trials were made to keep them alive but under no condition, moist or dry, did they live after five days. As this would not do for obtaining material for experimental purposes two cats infested with fleas were secured and these were kept in the insectary until the last of May when they were placed out of doors. Their bed consisted of several layers of newspapers which were shaken every few days into a dish, and thus from fifty to one hundred eggs were obtained each time.

The following method proved most successful in raising fleas from the eggs. The eggs with the débris, etc., from the beds, were put in Petri dishes and these placed on the stage in small moistening jars, one-third full of water (Plate X). The cover was put on the jar and the whole apparatus placed out of the direct light in the laboratory at ordinary room temperature. On exceptionally warm days the jar was partly opened to prevent the condensation of moisture in the jar from drowning the larvæ. A little floor sweepings from a vacuum cleaner and sometimes a little dried blood were added to the culture. The larvæ seemed to prefer the dust and their own molt skins to the dried blood. By this method



LYON—*Cat Flea.*

we were able to raise a generation, from egg to imago, in thirteen days as the minimum to thirty-three days as the maximum, depending upon the temperature. Moisture is essential for good results.

TABLE SHOWING TIME OF DEVELOPMENT.

Egg.	*Larva.*	*Pupa.*	*Complete generation.*
2–8 days	7–18 days	2–14 days	13–33 days

In order that we might easily collect the adults on emerging, the following device was used. After the larvæ had pupated (in pupating, the larvæ may spin a thin cocoon or may pupate without doing so, in either case the pupa stage is the same), the whole culture was suspended in a glass funnel, deep enough down to leave a clear space around the sides and not touching a glass plate cover which was placed over the top of the funnel. The tube of the funnel was inserted in a test tube and the entire apparatus attached to a ring stand. The fleas on emerging from the pupa jumped about and finally fell into the funnel and slid into the test tube below, where they could be easily collected and handled (Plate X).

OBSERVATIONS ON THE ANATOMY OF THE LARVA.

The statements and figures of the earlier authors, Laboulbène, Künckel and Taschenberg, are very indefinite but form the basis of most of the later work. In the first larval stage, the head is considerably longer than the other segments but in the last, third stage, it is of the same size. The egg breaker is lost after the first molt but the mouthparts remain the same.

The broad convex upper lip or labrum of the mouth of the cat flea is slightly emarginated in the middle with two small setæ at the center of either lobe (Fig. 1 C.) There are also two small hairs on either side. The labrum is used extensively in locomotion and in connection with the rest of the head to lift and turn over particles of food and in burrowing. In locomotion the two small setæ or bristles are fastened into the surface upon which the lava may be, and act as a brace while the "caudal stylets" at the extremity

of the body are being placed in preparation for exerting the power to force the body forward. The labrum is then relaxed and the larva darts forward in a rapid wriggling motion. On the under

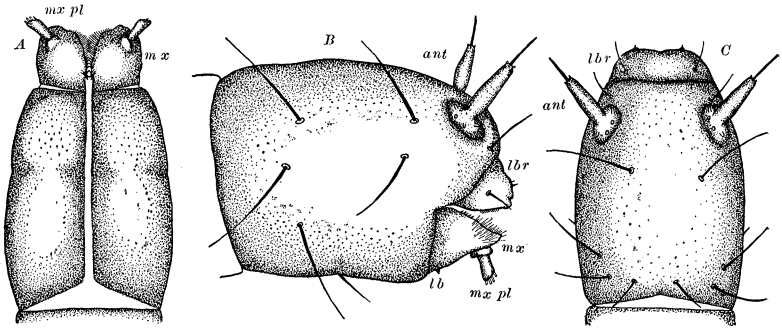


Fig. 1. *Ctenocephalus felis,* head of larva: *A,* ventral view; *B,* lateral view; *C,* dorsal view; *ant.,* antenna; *lb.,* labium; *lbr.,* labrum; *mx.,* maxilla; *mx. pl.,* maxillary palpus.

side of the labrum is a curved row of bristles which partially line the upper surface of the mouth and when closed meet the bunches of bristles on the ends of the maxillæ, thus holding the food in place in front of the mandibles.

The biting mandibles (Fig. 2 A), which are situated well inside the mouth, are strongly chitinized, broad and triangular and seem to be very powerful for such a larva, appearing more like those of Coleoptera than Diptera. The outer small end tapers gradually back and ends in a broad base with a single large lobe. The teeth appear, when the mandibles are in normal position, to be situated, not on the inside edge but somewhat back and on opposite sides of each mandible.

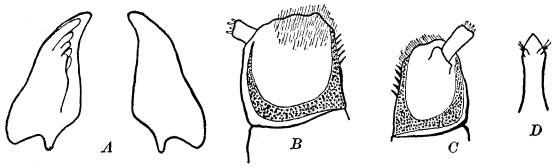


Fig. 2. *Ctenocephalus,* mouthparts of larva. *A,* mandibles; *B,* maxilla from inner side; *C,* maxilla from outer side; *D,* labium.

Thus, when the two mandibles are closed, they overlap each other. The teeth, six in number, are blunt and not sharp, as Künckel states, nor do the mandibles end in a sharp point. The

lobe at the base of the mandibles serves for the attachment of muscles and as a pivot by which they are moved.

Künckel describes the maxillæ (Fig. 2 B and C) as being sectors of a circular saw with the teeth on the greater part of their outline; Taschenberg, as being sickle-shaped on the outer edge, circular in shape on the inner edge which is provided with numerous fine teeth. The two maxillæ are provided on their inner cutting surfaces with five sharp-like saw teeth which point upwards. On the ends of the maxillæ are clumps of fine bristles or "brushes." These work against the curved line of hairs on the roof of the mouth. The bristles on the outer surface of the maxillæ interlock when in normal position. In the basal portion of the maxillæ, is a part, more heavily chitinized than the rest, which tapers up into a point on either side. Perhaps this is the sickle-shaped affair of Taschenberg. This is evidently a brace for the maxillæ, providing a suitable support for the attachment of muscles at the base and for the support of the palpi, which are two-jointed. The basal joint is short, broad and higher at one end than at the other. The second joint is short and stout, enlarging at its tip an oblique, flat end, bearing five small papilliform processes of unequal length which radiate somewhat.

The labium is situated well under the head (Fig 2 D). Laboulbène says that it is boat-shaped and divided in front, with two palpiform lobes. Künckel says that it is tongue-shaped with two very fine points making it bifid, having at its base two humps provided with two long and two short bristles. The labium is very small, narrow, slightly swelling near the end, with a blunt point which is turned upwards. Its bifid appearance is due to the presence of the labial palpi which are situated just back of the tip on the slightly enlarged portion and not at the base of the labium. The palpi consist of a short thick basal joint with four stout bristles, two of which are short and appear almost together, while the other two are longer and spreading. Like the terminal bristles of the antennæ, they do not taper. The base of the labium appears to end in the suture which extends medially the full length of the under side of the head.

In conclusion I wish to thank Professor C. T. Brues for his help in preparing the introduction and for the kindly interest which he has shown during the entire work.

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THE STIMULI WHICH CAUSE THE EGGS OF THE LEAF-OVIPOSITING TACHINIDÆ TO HATCH.

By Henry H. P. Severin, Harry C. Severin and William Hartung.

Some difference of opinion exists as to the stimuli which cause the eggs of the leaf-ovipositing Tachinidæ to hatch. The eggs of the leaf-ovipositing tachina contain fully developed larvæ at the time of deposition and are ready to hatch when swallowed by the host. Townsend (4, p. 109) suggests "that the digestive juices and conditions which the egg encounters in the alimentary canal of the caterpillar act upon the chitin and cause the shell to weaken so as to release the maggot." In direct opposition to this view, Swezy (3, p. 29) writes as follows: "The shell of the egg is so hard that it seems unlikely that it could be sufficiently affected by the digestive juices of the caterpillar, quickly enough to allow the maggot to escape from the egg, and also have time enough to pass through the wall of the alimentary canal before it would be carried along and be expelled with the frass of the caterpillar." Swezey (2, p. 8) first ventured the opinion that the eggs "are so small as to escape being injured by the jaws of the caterpillar in biting off bits of leaf," but in a later paper (3, p. 30) he changed his view