# SCIENCE:

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## NOTES FROM THE CORNELL INSECTARY.

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### II. — Some Observations Upon Plant-Lice

MORE than three-quarters of a century ago Kyber, a German observer, published under a similar title the results of experiments which not only confirmed the earlier observations of Bonnet and De Geer, but which also threw increased light on the generation and development of Aphids. Kyber found, for instance, that by keeping the insects in a warm room a series of agamic generations was produced which extended through four years without the intervention of the sexual forms. However, no record was kept of the number of generations produced during the time. In 1779, thirty-six years before Kyber's experiment, Bonnet had carried *Aphis sambuci* through nineteen generations without commerce with the male insect. From these and similar experiments a law has been educed, which we dare not deny, that "under certain circumstances a female Aphis may, without coupling, continue propagating to infinity, provided that the necessary conditions for the development of young — food and heat — are not wanting."

April 2, 1890, nearly two years and ten months ago, the writer isolated a nymph recently born of a wingless agamic female plant-louse, and since that time the experiment has been continued and is now in progress in the green-house at the Insectary of the Cornell Agricultural Experiment Station. The insect is probably *Myzus achyrantes* Monell, one of the "green-flies" of florists, which is always to be found in considerable numbers upon the varieties of *Achyrantes* grown in the Insectary; at one time it also attacked buckwheat and radishes growing in the green-house.

The experiment has been conducted in the following manner: The first nymph was isolated by placing her on a small plant known to be free from Aphids, and this plant was kept in a cage made by placing the flower-pot in a large saucer partly filled with sand, and then placing over the plant and pot a glass cylinder, which sank for a slight distance into the sand, and was covered with Swiss muslin at the top. The nymph was examined daily, and when she became a mother two or three of her young would be isolated in similar cages. When these daughters of the original mother became mothers themselves, their young would also be isolated, and so on. Not all of the young of each parent were allowed to live, and sometimes, to save cages, a mother would be removed to give place to one of her daughters; usually, however, a mother would not be destroyed until some of her daughters became mothers, for it frequently happened that some of the nymphs first isolated died before becoming mothers. In some cases the mother was left undisturbed, the young being removed and counted every day or two, to see how long she would live, how many nymphs might be born of a single mother, and whether there was any diminution in the reproductive power as generation after generation passed by without the male element again entering into the case. Great care has been taken to insure the isolation of the nymphs; when there was any doubt as to the pedigree of the nymph, she was immediately replaced by one of known pedigree.

Nothing but wingless agamic females have thus far been produced in the cages. Winged forms are sometimes seen, in April especially, on the other *Achyrantes* plants in the Insectary. The following table has been prepared to show the number of the generations, the rapidity with which they have been produced, and many other interesting points which have been brought out during the two years and ten months that the writer has cared for these little creatures — my pets, as I call them.

| Generations. | When Nymphs were Isolated. | When Motherhood Began. | Age When Reproduction Began. |
|---|---|---|---|
| 1 | 2 Apr. 1890 | 14 Apr. 1890 | 12 days |
| 2 | 18 " " | 30 " " | 12 " |
| 3 | 6, 9 May " | 18, 28 May " | 12 and 19 " |
| 4 | 26, 28 " " | 6, 11 June " | 11 " 14 " |
| 5 | 25 June, 9 July " | 12, 20 July " | 17 " 11 " |
| 6 | 12, 13 " " | 26, 31 " " | 14 " 18 " |
| 7 | 29 " " | 8 Aug. " | 10 " |
| 8 | 8, 9 Aug. " | 18 " " | 10 " 11 " |
| 9 | 20, 21 " " | 3, 1 Sept. " | 14 " 11 " |
| 10 | 1, 5 Sept. " | 13, 15 " " | 12 " 10 " |
| 11 | 18 " " | 17 Oct. " | 29 " |
| 12 | 17, 27 " " | 15, 10 Nov. " | 29 " 14 " |
| 13 | 10, 13 Nov. " | 11, 8 Dec. " | 31 " 25 " |
| 14 | 8, 11 Dec. " | 12, 5 Jan. 1891 | 35 " 25 " |
| 15 | 5, 12 Jan. 1891 | 26, 28 " " | 21 " 16 " |
| 16 | 26 Jan. 2 Feb. " | 14, 16 Feb. " | 19 " 14 " |
| 17 | 14 " " | 27 Feb., 4 Mar. " | 13 " 18 " |
| 18 | 27 Feb. 4 Mar. " | 20, 23 " " | 21 " 19 " |
| 19 | 20, 30 " " | 10 Apr. " | 21 " 11 " |
| 20 | 6, 8 Apr. " | 16, 20 " " | 10 " 12 " |
| 21 | 16, 21 " " | 27 Apr., 5 May " | 11 " 14 " |
| 22 | 27 " " | 10 " " | 13 " |
| 23 | 10 May " | 26 " " | 16 " |
| 24 | 27 " " | 10 June " | 14 " |
| 25 | 10 June " | 22 " " | 12 " |
| 26 | 24 " " | 10 July " | 16 " |
| 27 | 10 July " | 21 " " | 11 " |
| 28 | 21 " " | 30 " " | 9 " |
| 29 | 31 July, 14 Aug. " | 11, 24 Aug. " | 11 " 10 " |
| 30 | 24 " " | 5 Sept. " | 12 " |
| 31 | 5 Sept. " | 18 " " | 13 " |
| 32 | 23 " " | 5 Oct. " | 12 " |
| 33 | 5 Oct. " | 27 " " | 12 " |
| 34 | 27 " " | 11 Nov. " | 15 " |
| 35 | 14 Nov. " | 30 " " | 16 " |
| 36 | 3 Dec. " | 14 Dec. " | 11 " |
| 37 | 22 " " | 4 Jan. 1892 | 13 " |
| 38 | 4 Jan. 1892 | 23 " " | 19 " |
| 39 | 23 " " | 10 Feb. " | 18 " |
| 40 | 10 Feb. " | 24 " " | 14 " |
| 41 | 24 " " | 10 Mar. " | 15 " |
| 42 | 10 Mar. " | 25 " " | 15 " |
| 43 | 25 " " | 5 Apr. " | 11 " |
| 44 | 5, 12 Apr. " | 20, 25 " " | 15 " 13 " |
| 45 | 20 " " | 5 May " | 15 " |
| 46 | 5 May " | 13 " " | 8 " |
| 47 | 13, 16 " " | 25 " " | 12 " 9 " |
| 48 | 25 " " | 4, 7 June " | 10 " 13 " |
| 49 | 5 June " | 22 " " | 17 " |
| 50 | 22 " " | 4 July " | 12 " |
| 51 | 4 July " | 13 " " | 9 " |
| 52 | 13 " " | 22 " " | 9 " |
| 53 | 18 Aug. " | 1 Sept. " | 14 " |
| 54 | 1, 6 Sept. " | 13 " " | 12 " 7 " |
| 55 | 16 " " | 26 " " | 10 " |
| 56 | 26 " " | 7 Oct. " | 11 " |
| 57 | 7 Oct. " | 22 " " | 15 " |
| 58 | 22 " " | 7 Nov. " | 16 " |
| 59 | 7 Nov. " | 21 " " | 14 " |
| 60 | 21 " " | 6 Dec. " | 15 " |
| 61 | 9 Dec. " | 27 " " | 18 " |
| 62 | 27 " " | 17 Jan. 1893 | 21 " |

Let me point out a few of the most interesting facts to be gleaned from an examination of the above table. Sixty-two generations have been produced thus far, or nearly two (1.8) generations a month on an average. The extremes were in the 13th and 14th generations, when it took a month for a generation to develop; and in the 46th, 47th, and 48th generations, which were all produced within a month.

This difference was due to the fact that the plants had become old, stunted, and pot-bound when the 13th and 14th generations of the Aphids were produced, while in the other case the plants were young and vigorous. It was also found that this difference in the plants produced not only the retardation of development of the Aphids, but there was also a very marked difference in their size and reproductive power. On these stunted plants it takes from two to three times as long for the nymph to develop, it does not attain more than one-third the size, and less than one-third

as many young are produced as there would be if the nymph were reared upon a vigorous young plant. I have seen mother Aphids, on old plants, which were not larger than nymphs after their second moult on young plants. In the 12th generation this point was well illustrated. Here we have the record of two nymphs, the first, isolated Sept. 17 on an old pot-bound plant, did not become a mother until Nov. 15, or 29 days after; while a nymph, isolated 10 days later on a young, vigorous plant, attained motherhood in 14 days. The 19th generation presents a similar case. Nymphs born of these dwarfed and retarded mothers and placed on young plants have become normal-sized mothers in from 15 to 18 days in my cages.

In one instance (54th generation) a nymph became a mother in 7 days, while one of the 14th generation was 35 days in attaining the adult stage. I believe, that by carefully watching the Aphids and always isolating the first nymphs born upon young, vigorous plants, that at least thirty generations of this *Achyrantes* Aphis could be produced in a year. In 1890, Mr. W. J. MacNeil, while studying a black chrysanthemum Aphis, at the Insectary, reared, in 13 months and 5 days, thirty-two generations of the insect, all agamic wingless females. As the table shows, I have reared from twenty to twenty-five generations of the *Achyrantes* Aphis in a year.

As the experiment progressed, many other interesting facts were learned which could not be included in the table. I will now briefly discuss some of them.

The mother Aphids were often caught in the act of giving birth to a daughter. The operation required about five minutes, and in every instance the nymph was born tail end first in a thin transparent sheath or pellicle. Before being entirely delivered from the mother, however, the nymph begins to work the pellicle off; the antennæ and first pair of legs are freed about the same time, then follow the remaining legs and the honey-tubes, and the pellicle appears as a minute whitish mass about the tail of the nymph. The nymph remains attached to the mother until its appendages are free and the little creature is able to stand alone.

There seems to be no published record of the young of wingless agamic female Aphids being born in a pellicle as just described. Buckton gives five or six instances in as many genera where the young of winged agamic females are born thus. I believe, however, that this manner of giving birth to their young is as common among the wingless as among the winged agamic forms of Aphids. I have observed it many times in the case of *Myzus achyrantes*, and several times in the field among other common species. Mr. MacNeil showed it to be true of the black chrysanthemum Aphis; and Mr. W. E. Rumsey, while studying the woolly apple-louse, *Schizoneura lanigera*, here at the Insectary, watched under a compound microscope one of the wingless agamic females giving birth to a daughter, and there was no doubt that the nymph was born in a pellicle. This last case is contrary to the observations of Mr. L. O. Howard as published in Comstock's Report as U. S. Entomologist for 1879, p. 259; but the fact remains that a wingless agamic female of *Schizoneura lanigera* here at the Insectary has been clearly seen in the act of giving birth to several nymphs, each enveloped in a pellicle.

The nymphs begin to suck the sap of the plant very soon after birth, and as they increase in size moults occur. The minuteness of the insects and the delicacy of their cast skins renders the observation of the numbers of the moults very difficult. I worked nearly five months before I satisfactorily settled the fact that the *Achyrantes* Aphis moults four times during its lifetime. My method was to use a small plant with a few leaves and place a piece of stiff black paper close around the plant on the surface of the soil. This was necessary, as the delicate white cast skins frequently fell from the plant and would have been easily lost unless this smooth black surface had caught them.

The records of four nymphs of the 7th, 9th, and 15th generations show that the first moult occurs from 3 to 4 days after birth; the second from 2 to 5 days after the first; the third from 1 to 3 days after the second; and the fourth from 3 to 5 days after the third. In one instance, when the growth of the nymph was retarded by a stunted plant, its moults occurred about one week apart. It requires from 15 to 20 minutes to complete a moult.

The nymphs of a black chrysanthemum Aphis and of *Schizoneura lanigera* also moulted four times, as recorded in the theses of Messrs. McNeil and Rumsey. *Pemphigus filaginis* and *Tetraneura ulmi* are also recorded as moulting four times; thus four seems to be the normal number of moults among plant-lice.

Under the more even temperature during all the seasons in a green-house, plant-lice there do not show such a wonderful fecundity and rapidity of production as has been recorded from field observations. The table above shows that the seasons have no material effect upon the rapidity with which the generations are produced in a green-house.

To ascertain whether the fecundity of the Aphids diminished through the successive generations of the agamic females, I counted the number of nymphs born of a single mother in several instances. During the 1st and 2d generations, 37 nymphs were born of a single mother. In the 3d generation, 3 to 4 nymphs were born each day of a single mother for 14 days in succession. A mother of the 18th generation lived 63 days and gave birth to 59 young. In the 20th generation a mother gave birth to 62 daughters in 19 days, or at the rate of three a day. Sixty-one nymphs were born of a mother of the 35th generation in one month. A mother of the 46th generation gave birth to 15 young in 3 days. Fifty-four daughters were born to a single mother of the 41st generation. And in the 54th generation a mother gave birth to 55 young. It is thus seen that the reproductive power of the agamic females has not decreased through nearly 60 generations.

Mr. MacNeil had one wingless agamic female of the black chrysanthemum Aphis which gave birth to 70 young in 34 days; at one time 7 were born in 27 hours. Mr. Rumsey reared in one instance 68 nymphs in 65 days from a wingless agamic female of *Schizoneura lanigera;* this female lived 12 days after the birth of the last nymph, and was nearly three months old when she died. From another female Mr. Rumsey reared 86 young in 55 days. Several of the agamic females of the *Achyrantes* Aphis have lived two months after becoming mothers.

To learn whether winged females might not be produced if the plants became overcrowded with the Aphids, I allowed, in several instances, reproduction to go on undisturbed in the cages. Several hundred wingless females would accumulate on a small plant, and possibly winged forms might have been forced in time if in each instance the overcrowding had not been checked by a fungous growth, which set in and destroyed a majority of the insects.

Many volumes have been written upon the habits and life histories of plant-lice; enough has been written upon the grape Phylloxera alone to fill a small library. And yet we have much to learn about plant-lice. I believe they present as varied, peculiar, interesting, and wonderful phases in their habits and life histories as do any other insects.

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## THE EXTREME HEAT AND COLD ENDURED BY MAN.

BY THE MARQUIS DE NADAILLAC, PARIS, FRANCE.

THE exceptional faculties of Man enable him, alone of all the mammals, to battle with extreme cold as with extreme heat, and it is with real astonishment that we ascertain what men of our race can endure. In the earliest times of which we have any knowledge, we have strong evidence that our species lived, both in America and in Europe, when large extents of both continents were covered with ice and when his companions were the elephant and the woolly rhinoceros. Later, the Aryan race, whatever may have been its birthplace, reached step by step in the south the Gangetic Peninsula, 8° only removed from the equator, and, in the north, Iceland and Greenland, which seem the extreme points attained by our most prolific race in those days so distant from ours.

A few years ago the English and Russian officials assembled at Maruchak for the delimitation of Afghanistan suffered a mean temperature of — 20° C., which was considered moderate in those regions. In his eventful journey across the mountains of Central Asia, utterly unknown to us, Prince Henry of Orleans had to