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THE SUSCEPTIBILITY OF SOME AMERICAN WHEATS TO THE WHEAT BLOSSOM MIDGES

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One of the Wheat Blossom Midges, *Sitodiplosis mosellana* (Géhin), has occasionally been recorded as injurious in Canada and the United States. The other, *Contarinia tritici* (Kirby), has never been confirmed as occurring in North America, although before 1912 many authors mistakenly reported its presence. Comprehensive accounts of both species are given by Barnes (1956).

The purpose of this investigation was to determine whether American wheats bred for their resistance to Hessian Fly show any resistance to either of these two midges.

The experiment consisted simply in growing certain wheat varieties in a locality where both the Wheat Blossom Midges occur and in assessing the subsequent infestation of each variety by each of the midges.

The wheat varieties used were the same as those tested for their resistance to Hessian Fly of mixed foreign parentage (Barnes, 1960): namely Peko, an English spring wheat; Marquardts brauner Dickkopf, a German winter wheat that has been recorded by German workers as having exceptionally low infestations, especially by *C. tritici;* and seven winter and two spring American varieties. These were in order of known resistance to Hessian Fly in America; Durum (P.I.94587), a spring wheat, and Pawnee x P.I.94587 (12855); Mediterranean-Hope-Pawnee x Oro-Ill.I-Comanche (12804), Dual (13083), Gelou-Oro x Cheyene-Tenmarq (KS 46799) and Ill.no.IW 38, a spring wheat; Ponca (12128) and Marquillo-Oro x Triunfo (12858); and Tenmarq (C 16936). These varieties show a wide range in awn-length as illustrated in Plate I.

METHODS

These were similar to those previously used to assess the infestation of three spring wheats (Atle, Svenno and Fylgia) by the Wheat Blossom Midges (Barnes, Miller & Arnold, 1959).

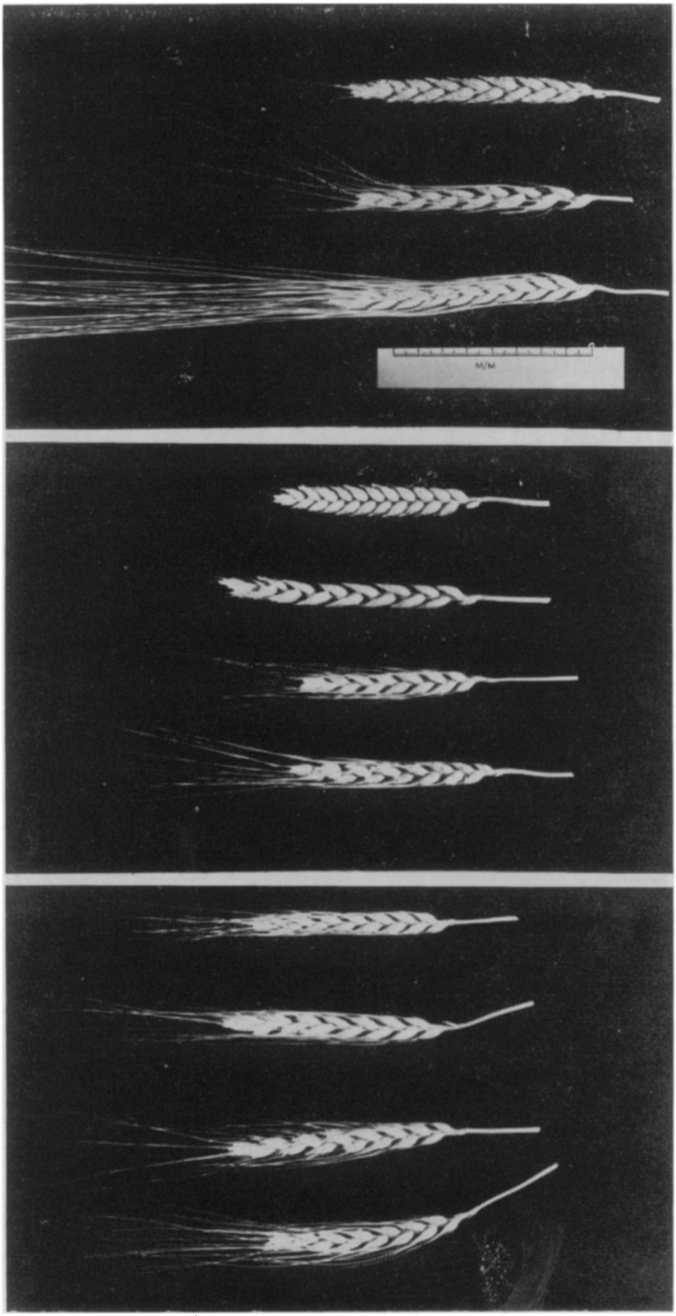

PLATE 1. Ears of the wheats tested to demonstrate the awn-length. 1. Tenmarq, 2. Ponca, 3. Pawnee x P.I. 94587, 4. Mediterranean-Hope-Pawnee x Oro-Ill.I-Commanche, 5. Marquillo-Oro x Triunfo, 6. Gelou-Ora x Cheyenne-Tenmarq. 7. Dual, 8. Marquardts brauner Dickkopf, 9. Durum, 10. Ill.no.IW 38 and 11. Peko. (Rothamsted Experimental Station copyright.)

The wheats were sown in seed boxes or flats to avoid damage by slugs, mice and birds and kept in an open unheated glasshouse. One sowing of the winter wheats was made on 27 November 1958 and of the spring wheats (Durum, Ill.no.IW 38 and Peko) on 5 March 1959. A second sowing of the winter wheats was made on 5 February and of the spring wheats on 12 March.

The wheats were later transplanted into double rows, about 15 ft. long, in the garden of Rothamsted Lodge. These rows were covered with wire netting to avoid destruction by sparrows that were known from previous experience frequently to uproot young seedlings and eat the remains of the grain. The winter wheats of the first sowing were planted out on 25-26 February and the spring wheats on 25 March. The winter wheats of the second sowing were planted out on 23-24 March and the spring wheats on 9 and 10 April. It was obvious later that the earlier transplanted wheats scarcely tillered, whereas the later transplants tillered freely and provided bottom-cover for the flying midges.

At the time of ear-burst, the visible ears were counted each morning and the *C. tritici* and *S. mosellana* ovipositing on the ears were counted each evening, between 16.30 and 19.00 hours G.M.T. It was realised that this time of day was rather early for oviposition by *C. tritici,* even though the wheat rows were by then in partial shade, and much too early for oviposition by *S. mosellana.* These counts started on 4 June when the first *C. tritici* females were seen, and continued until 2 July, by when the flight of midges was apparently over because no midge had been seen on the ears since 30 June. The daily numbers of both midges that emerged in the insectary at Rothamsted Lodge were available for comparison. It should be remembered that the midges are short-lived and lay most of their eggs the same day that they emerge.

On 2 July a sample of 25 ears from each variety in the earlier transplant was collected and examined later for the numbers of grains infested and numbers of larvae per infested grain. On 3 July the remaining ears of this transplant were cut and 50 of each variety were later examined. This examination was in more detail. The spikelets and grains per ear were counted, as were the infested grains and larvae per infested grain.

The infestation in the later transplant was assessed in the same two ways. It was decided to cut all the ears on 9 July, but unfortunately after six varieties had been harvested there was a thunderstorm in which 0.49 inch of rain fell in about one hour. The remaining varieties (Dual, Durum, Ill.no.IW 38, Marquardts and Peko) were therefore harvested a day later. Full-grown larvae of these midges are liable to leave the ears suddenly when rain follows dry weather, so the figures for infestation of these five varieties were expected to be comparatively less than those of the varieties collected before the rain came. It was possible to compare the infestation on Gelou-Oro x Cheyenne-Tenmarq on 9 July, before the rain, and on 10 July, after the rain, because this variety was partially harvested before the storm started.

OVIPOSITION

Figure 1 shows the numbers of *C. tritici* females seen on the rows of wheat varieties in the first and second transplants and the numbers that emerged daily in the insectary. The first specimen was seen on the first transplants on 4 June and on the second transplants on 7 June; the peaks were respectively on 18 and 19 June; the last individuals were seen on 29 and 30 June. In the insectary the females started emerging on 10 June, reached a peak (174) on 19 June, and the last one emerged on 2 July.

Few *S. mosellana,* as was expected, were seen ovipositing, but the first was seen on 7 June. Most (47) were seen on 20 June and the last on 29 June. In the insectary the first female emerged on 7 June, the peak (103) occurred on 21 June and the last emerged on 4 July.

Table 1 shows the numbers of *C. tritici* females seen on the various wheat varieties throughout the period of observation. Many more midges were seen on second than on the first transplants.

TABLE 1. Numbers of *C. tritici* Seen Ovipositing 4-30 June.

Variety	1st transplant	2nd transplant
Winter wheats		
Tenmarq (C.16936)	143	464
Ponca (12128)	36	260
Pawnee x P.I.94587 (12855)	83	344
Mediterranean-Hope-Pawnee x Oro-Ill.I-Comanche (12804)	47	261
Marquillo-Oro x Triunfo (12858)	62	377
Gelou-Oro x Cheyenne-Tenmarq (KS 46799)	44	436
Dual (13083)	122	1252
Marquardts brauner Dickkopf	89	92
Spring wheats		
Durum (P.I.94587)	142	284
Ill.no.IW 38	229	408
Peko	126	416

EAR-BURST OF THE WHEAT VARIETIES

Figure 2 shows the numbers of ears visible each day from 4 June to 2 July on six varieties (Marquillo-Oro x Triunfo, Dual, Durum, Ill.no.IW 38, Marquardts and Peko) in the first transplant rows. Figure 3 shows the ear-burst of the same six varieties in the second transplants.

The progress of ear-burst of the remaining varieties followed closely that of Marquillo-Oro x Trinunfo. Full data are available. The number of visible ears increased uniformly and at much the same time in most of the varieties, but ear-burst of two spring varieties, Durum and Peko, and one winter wheat, Marquardts, was much later in both transplants. That of the remaining spring wheat, Ill.no.IW 38, was as early as the majority of the winter wheats. One winter variety, Dual, started earing later than the others, but its rate increased more rapidly. The percentage ear emergence of each variety on the day of the peak emergence of *C. tritici* is given in Table 2. The first transplanted wheats on the whole had a greater percentage of their ears visible when the peak of *C. tritici* emergence was reached. But the total number of ears emerged on that date was greater in the rows of six of the eleven varieties of the second transplant than in those of the first transplant.

TABLE 2. Percentage Ear Emergence at Peak of *C. tritici* Emergence.

Variety	1st transplant	2nd transplant
Winter wheats		
Tenmarq (C.16936)	75	54
Ponca (12128)	64	68
Pawnee x P.I. 94587 (12855)	71	49
Mediterranean-Hope-Pawnee x Oro-Ill.I-Comanche (12804)	79	65
Marquillo-Oro x Triunfo (12858)	78	68
Gelou-Oro x Cheyenne-Tenmarq (KS 46799)	74	68
Dual (13083)	60	35
Marquardts brauner Dickkopf	6	0
Spring wheats		
Durum (P.I.94587)	29	25
Ill.no.IW 38	56	57
Peko	0.8	1.4

INFESTATION

Table 3 gives the infestation of each of the transplants. The average number of larvae per infested grain indicates that the samples were taken before appreciable numbers of larvae had left the ears. Nevertheless

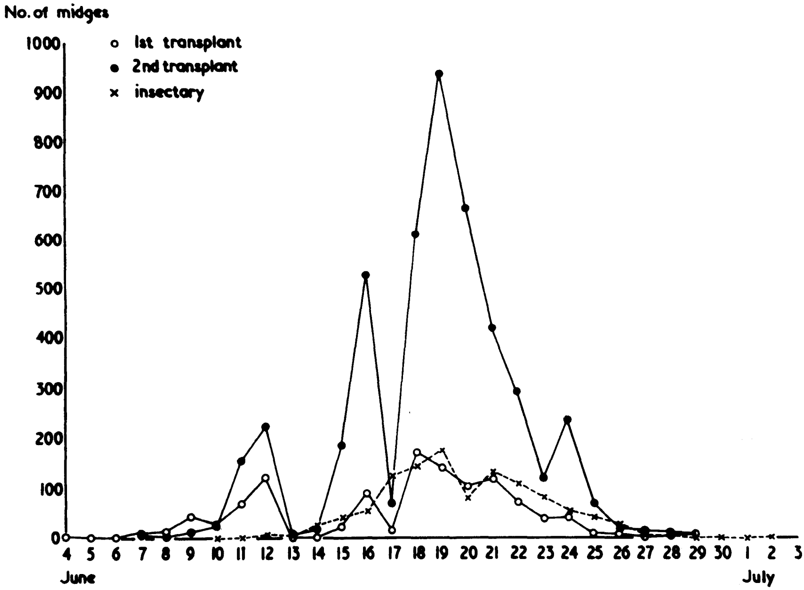

FIG. 1. Numbers of female *C. tritici* seen daily on the ears of the first and second transplanted wheats, together with those emerging in the insectary.

the fact that the average number of *C. tritici* larvae on nine of the eleven wheat varieties was lower in the second transplant samples than in the

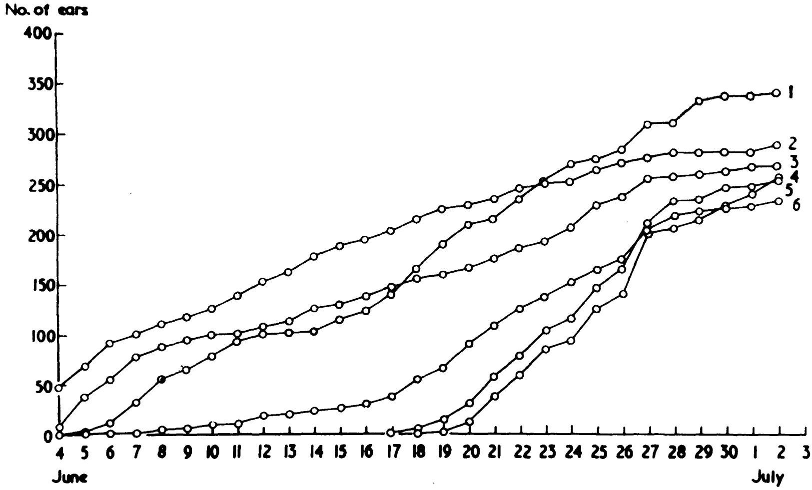

FIG. 2. Ear-burst of 1. Ill.no.IW 38, 2. Marquillo-Oro x Triunfo, 3. Dual, 4. Peko, 5. Marquardts brauner Dickkopf and 6. Durum, in the first transplanted rows.

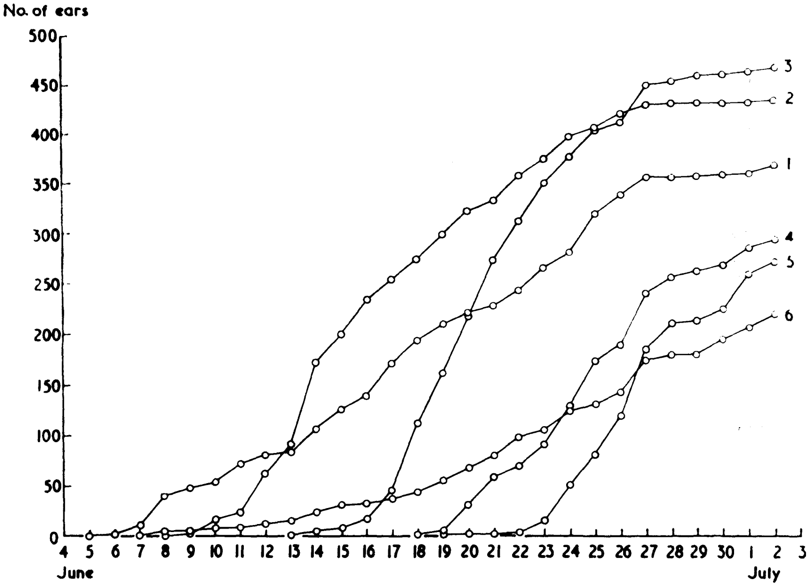

FIG. 3. Ear-burst of 1. Ill.no.IW 38, 2. Marquillo-Oro x Triunfo, 3. Dual, 4. Peko, 5. Marquardts brauner Dickkopf and 6. Durum, in the second transplanted rows.

first indicates that the larvae of this species had started to leave between 3 and 9 July.

Seven of the winter wheats (Tenmarq, Ponca, Pawnee x P.I.94587, Mediterranean-Hope-Pawnee x Oro-Ill.I-Comanche, Marquillo-Oro x Triunfo, Gelou-Oro x Cheyenne-Tenmarq and Dual) and one spring wheat (Ill.no.IW 38) had percentage grain infestations by *C. tritici* ranging from 4.0 to 10.3 in the first transplant and from 5.0 to 10.6 in the second. The intensity of attack, particularly on the second transplants, is comparable to that on Plot B on the Broadbalk wheat (Square Heads Master) on 5, 7 and 9 July. Samples taken on Broadbalk field on 13 July were less infested because by then many of the larvae had left the wheat. On the remaining winter wheat, Marquardts, and the two other spring wheats, Durum and Peko, the infestations were much lower. This is because ear-burst occurred on them when the year's flight of midges was nearly ended. Seven of the eleven varieties in the second transplants had a larger percentage of their grain attacked than did the first. *C. tritici* larvae were more numerous on five of the varieties in the second transplants than in the first.

With one exception the infestations by *S. mosellana* fell into similar groups of higher and lower attacks. Six of the seven wheats that had the higher infestations by *C. tritici* had infestations by *S. mosellana* ranging from 4.6 to 9.5 percent grain attacks in the first transplants and from 8.2 to 12.7 in the second. The seventh, Marquillo-Oro x Triunfo, had only 1.2 and 3.4 percent attacks respectively in the two transplants. The three varieties in which earing was late in comparison with the midges' flight period had low infestations. All eleven varieties showed increased percentage grain attack and number of larvae in the second transplant over the first.

DISCUSSION AND CONCLUSIONS

The close parallelism between the emergence dates of the Wheat Blossom Midges in the insectary at Rothamsted Lodge and in the open was once again shown.

Bottom-cover has long been known to afford protection to Wheat Blossom Midges. This was confirmed by the fact that a total of 4,594 *C. tritici* were seen on the ears of the second transplants that had tillered freely whereas only 1,123 were seen on those of the first transplants that had not.

The uniformity of date of ear-burst among the varieties of winter wheat sown on 27 November and transplanted in the open on 25-26 February, as well as between those sown on 5 February and transplanted outside on 23-24 March, is striking. The exception was the German variety Marquardts brauner Dickkopf. The late start but more rapid development of ear-burst of Dual of the second transplant should also be mentioned. This uniformity was not noticeable in spring wheats, of which one set was sown on 5 March and the other on 12 March and transplanted outside on 25 March and 9 and 10 April respectively.

C. tritici was seen ovipositing freely on all the varieties. The length of awn did not appear to affect egg-laying and many midges laid on Durum, which has the longest awns. It is true that most were seen on the ears of

TABLE 3. Infestation of the First Transplanted Wheats on 3 July 1959 (Above).
Infestation of the Second Transplanted Wheats on 9 and 10* July 1959 (Below).

Variety	Total larvae in 50 ears		Percentage grain attack		Average number of larvae per infested grain	
	T	M	T	M	T	M
Winter wheats						
Tenmarq (C. 16936)	2055	211	9.8	6.5	10.8	1.7
Ponca (12128)	808	124	5.2	6.3	12.1	1.5
Pawnee x P.I.94587 (12855)	1853	214	10.3	9.5	10.6	1.3
Mediterranean-Hope-Pawnee x Oro-Ill.I-Comanche (12804)	1297	208	8.1	9.0	11.0	1.6
Marquillo-Oro x Triunfo (12858)	986	30	5.4	1.2	11.0	1.5
Gelou-Oro x Cheyenne-Tenmarq (KS 46799)	555	97	4.3	4.7	9.6	1.5
Dual (13083)	600	138	4.0	4.9	7.7	1.5
Marquardts brauner Dickkopf	93	15	0.3	0.5	10.3	1.2
Spring wheats						
Durum (P.I.94587)	563	115	2.4	3.4	9.5	1.4
Ill.no.IW 38	1495	109	8.3	4.6	10.2	1.3
Peko	109	2	0.8	0.1	6.4	1.0
Winter wheats						
Tenmarq (C.16936)	1171	265	8.2	10.9	9.1	1.6
Ponca (12128)	605	145	5.0	9.4	10.6	1.4
Pawnee x P.I.94587 (12855)	1642	220	10.5	10.0	10.4	1.5
Mediterranean-Hope-Pawnee x Oro-Ill.I-Comanche (12804)	1843	259	10.6	12.7	11.7	1.4
Marquillo-Oro x Triunfo (12858)	1340	74	7.0	3.4	12.1	1.4
Gelou-Oro x Cheyenne-Tenmarq (KS 46799)	1396	213	8.4	8.6	10.5	1.6
Dual (13083)*	1214	206	9.5	8.2	7.0	1.4
Marquardts brauner Dickkopf*	43	85	0.2	2.6	7.2	1.3
Spring wheats						
Durum (P.I.94587)*	173	129	0.9	3.8	8.2	1.4
Ill.no.IW 38*	1376	296	9.8	12.3	8.2	1.4
Peko*	326	61	1.6	2.6	11.2	1.3

Note: T indicates *C. tritici*, M indicates *S. mosellana*.

the secondly transplanted Dual, which has very short awns, but this may have happened because of the large amount of bottom-cover for the midges in the immediate proximity.

There was no apparent relation between the numbers of *C. tritici* seen ovipositing on the ears and the subsequent larval infestation, but no relation could be expected because the observations covered only a small portion of the daily time when oviposition could have happened. Such observations enable the flight period of the year to be studied in relation to ear-burst. Observations to get comparable results with *S. mosellana* would have to be made considerably later each evening.

Ear-burst of the winter wheat Marquardts and the spring wheats Durum and Peko did not coincide with the flight period of the midges, so no information was gained about the degree of susceptibility of these three varieties. Peko has previously been shown to be susceptible (Barnes, Miller & Arnold, 1959).

The fact that the remaining eight varieties tested were infested similarly to Square Heads Master on Broadbalk field indicates that the site chosen for the experiment is a good one and also that these varieties, with one exception, exhibit no sign of being resistant to either of the Wheat Blossom Midges.

None of the eight varieties, Tenmarq, Ponca, Pawnee x Durum, Mediterranean-Hope-Pawnee x Oro-Ill.I-Comanche, Marquillo-Oro x Triunfo, Gelou-Oro x Cheyenne-Tenmarq, Dual and Ill.no.IW 38, exhibited any difference in susceptibility to *C. tritici.*

The same is true, with one exception, of susceptibility to attack by *S. mosellana,* the species that already occurs in Canada and the United States. The exception is Marquillo-Oro x Triunfo, which was less infested (1.2 & 3.4%) than the others. This cannot be accounted for by too few ears on which the midges could oviposit. A few *S. mosellana* were seen ovipositing on this variety, but unfortunately the observations of midges' egg-laying were made too early in the evening to get much information. The only conclusion that can be drawn is that Marquillo-Oro x Triunfo appears to be the only one of the eight varieties successfuly tested that is worthwhile including in any further trial or selection of varieties possibly resistant to *S. mosellana.*

SUMMARY

Seven American varieties of wheat resistant to Hessian Fly and one susceptible to it are susceptible to *Contarinia tritici* (Kirby) which is not yet known to occur in North America. All these are also susceptible to the other Wheat Blossom Midge, *Sitodiplosis mosellana* (Géhin), which does occur in North America. But Marquillo-Oro x Triunfo (12858) seems to be less susceptible.

The information gained about three other varieties, Marquardts, Durum and Peko, must be discounted because their ear-burst did not coincide with the midges' flight period.

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A DOUBLE MOUNT FOR MINUTE ARTHROPODS[1]

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A mount for unusually small Arthropods, which has been in use at the University of Arkansas for several years, appears to have certain advantages over others known to be in use. It is inexpensive, probably a little faster than other methods, and enables the technician to use such a small and accurate point of attachment to the specimen that no important structures are obliterated. In this respect it is at least as good as minuten nadeln, and incomparably better than card points.

The secondary support for the specimen is a slender plastic thread. This is made by holding two insect pins close together and applying a drop of plastic cement commonly to both, at a point ⅜ inch from the heads of the pins. The pins are then pulled about ¾ inch apart, which results in a thread being formed between them. They are held in this position for several minutes, after which the thread is clipped midway between the pins. The result is a thread projecting at right angles from each pin.

Mechanical aids are used for placing, separating and holding the pins steady while the thread is drying. These will not be described, since there are a number of ways of doing it which can easily be devised.

To mount the insect, it is placed in position under a binocular microscope with the right side up. The tip of the thread is brought close to it, ready for instant application. With the other hand, the specimen is flooded momentarily with a drop of some solvent of the cement, using an eyedropper. As the solvent evaporates, the specimen is watched closely. Just as the last bit of liquid is about to leave the body part where attachment is to be made, the thread is brought in contact with it. Everything is then held motionless for a few seconds until all the solvent has evaporated, after which the mount is lifted with the specimen attached.

The basic advantage of the method, other than the fineness of the thread, is the fact that it manufactures its own adhesive, in small amount and at the precise spot where it is needed, and at the moment of attachment so that there is no premature drying of adhesive.

Various cements and solvents can be used, but Duco household cement and acetone for the solvent have been most commonly employed.

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[1] Published with the approval of the Director of the Arkansas Agricultural Experiment Station.