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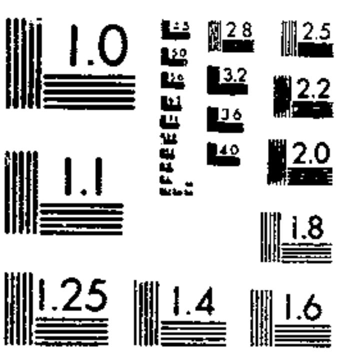

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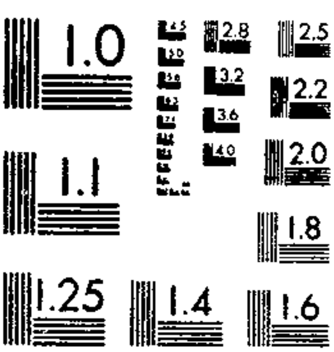

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Technical Bulletin No. 1000 • November 1949

UNITED STATES
DEPARTMENT OF AGRICULTURE
WASHINGTON, D. C.

Mote Types in Cotton and Their Occurrence as Related to Variety, Environment, Position in Lock, Lock Size, and Number of Locks Per Boll[1]

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INTRODUCTION

Varying numbers of the potential seeds of a cotton crop fail to grow into seeds with ginnable, well-developed fibers. The ovules that fail to ripen into mature seeds develop into aborted structures that vary in degrees of seed, fiber, and embryo development. These structures are termed "motes."

The motes in a cotton crop represent a loss in yield. If 15 to 20 percent or more of the ovules fail to produce seeds with ginnable fiber, the potential yield is lowered by just that much.

Motes may be important in still another way. Under certain conditions, either because the cotton contains a very large number of motes or because the cotton was ginned with the mote board in such a posi-

[1] Submitted for publication April 21, 1949. This study is part of the regional variety investigations conducted jointly by the Bureau of Plant Industry, Soils, and Agricultural Engineering, and the Cotton Branch, Production and Marketing Administration, United States Department of Agriculture. Acknowledgment is made to the agricultural experiment stations of North Carolina, South Carolina, Mississippi, Arkansas, Louisiana, Oklahoma, and Texas for providing the samples that made these studies possible and to the Delta Branch Experiment Station, Stoneville, Miss., in particular for special plantings made in 1937 and 1939.

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tion that the moting action was restricted, enough motes may escape into the lint to form a not inconsiderable fraction of the weight of the entire bale.[2] Thus, in the purchase of large quantities of cotton, considerable waste may be bought at the price of good fiber.

Finally, motes are a source of small imperfections in yarn and cloth. The largest motes have fiber long enough to be ginned. These fibers are usually very thin walled and are therefore undesirable, since upon manipulation they may readily tangle into neps (*11*).[3] In addition, motes may be broken or crushed, either during ginning or early stages of manufacturing, and the small fragments resulting may escape into the yarn, remaining there as small undesirable specks (*11*).

Several investigators have studied motes and have reported variations with variety, year of growth, time of picking, position in the lock, and number of locks per boll (*1*, *2*, *15*, *16*, *17*). One author presented a mote classification (*15*).

In connection with the regional variety investigations of the Bureau of Plant Industry, Soils, and Agricultural Engineering (*14*)[4] it has been possible to make a more complete study of mote types and their occurrence than had been made heretofore. This bulletin presents the results of this investigation, together with those of some related studies, and includes a description of the kinds of motes that may be found in seed cotton and their occurrence as related to variety, location and year of growth, date of bloom, position in the lock, number of ovules per lock (lock size), and number of locks per boll (boll size).

MATERIALS AND METHODS

The materials studied were four different sets of samples of seed cotton (*Gossypium hirsutum* L.). The first two sets are designated as the special-planting samples, set I and set II. These samples were derived from special plantings made at the Delta Branch Experiment Station, Stoneville, Miss., in 1937 and 1939. The 1937 plantings consisted of the 16 varieties that were included in the 1935–37 regional variety investigations (*14*) plus a variety known as Slick-Seeded Acala.[5] The 1939 plantings consisted of only five of the varieties.

Set I was used to study mote types and to make a preliminary study of the extent to which the formation of motes might vary with variety, position in the lock, lock size, and number of locks per boll. The samples were obtained as follows: For each of the 17 varieties planted in 1937, 75 blooms were tagged on approximately every other day throughout the blooming period. Each variety sample consisted of all bolls that developed from these blooms. The samples varied considerably in size, Acala (Rogers) being represented by the fewest bolls (413) and Triumph (Oklahoma) 44 by the most (678).

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[2] Calculations based on the weight of motes and mote fragments in 22-gm. samples of ginned lint showed that the weight of such waste in a 500-pound bale of cotton may range from 2 to 8 or even 10 pounds, or more under extreme conditions. (Unpublished information.)

[3] Italic numbers in parentheses refer to Literature Cited, p. 36.

[4] BARRE, H. W. NATURE AND SCOPE OF THE COOPERATIVE REGIONAL VARIETY STUDIES WITH COTTON. Paper presented before the Amer. Soc. Agron., New Orleans, La., Nov. 22-24, 1939. 5 pp. [U. S. Bur. Plant Indus. processed copy.]

[5] Not a commercial variety.

Set II of the special-planting samples was used primarily to investigate the extent to which mote formation might vary among bolls representing different days or portions of the blooming period (seasonal trend). The samples were obtained in the following manner: For each of 6 varieties grown in 1937 and 5 grown in 1939, 50 plants were selected for special tagging. One plant was allowed to a hill, and the plants from alternate hills in the same row were removed. Large plants were thus produced, and in 1937 the blooming period was prolonged considerably. The blooming period was not materially lengthened in 1939, however. The blooms on each plant were tagged every day beginning with the 8th of July in 1937 and with the 5th in 1939 and ending when it appeared likely that few succeeding blooms would set fruit. The mature bolls were collected and grouped for each variety as to date of bloom. The total number of bolls collected for any one variety ranged in 1937 from 699 to 1,892 for Qualla and Delfos (Missdel) 4, respectively, and in 1939 from 797 to 1,479 for Slick-Seeded Acala and Delfos 4, respectively. The maximum boll yield for any one day in 1937 was 91 for Delfos 4 on the 24th of July and in 1939 was 112 likewise for Delfos 4 on the 20th of July.

The third and fourth sets of samples each represent certain portions of the 1935–37 regional variety investigations of the Bureau. The third set represents the spinning test series (*12*) and was used herein to show by means of statistical analysis variation in mote formation with variety, location, and year of growth. It consisted of 767 [6] seed-cotton samples representing 2 replications for 16 varieties grown at 8 locations for 3 successive years. The varieties and locations are listed in table 1. The original seed-cotton samples for the spinning test series consisted of 2-pound lots. The subsamples taken from these for use in the study described herein consisted of 1,000 seeds and motes each. In making up the subsamples each 2-pound sample was divided into 4 portions and 250 seeds and motes were taken from each.

The fourth set of samples was used to show the relation between mote formation and position in the lock, lock size, and number of locks per boll. It consisted of 768 samples representing 8 replications for 4- and 5-lock bolls of the same 16 varieties comprising the spinning test series, but grown at 3 locations (Statesville, N. C., Baton Rouge, La., and Lubbock, Tex.) in 1937 only. Each sample consisted of 100 locks selected from the original 100 4-lock- and 5-lock-boll samples of the regional variety investigations.

In making up the 100-lock subsamples, the 100-boll samples were each divided into 4 or 5 lots in an attempt to get an even distribution of the locks of each boll among all the lots. Such a distribution could not be accomplished with certainty, for although the locks comprising a boll could frequently be recognized as such, a variable part of each 100-boll sample consisted of a mass of separate or even broken locks. To make up a sample of 100 seemingly intact locks for each 100-boll sample, it was usually necessary to add to 1 of the subsamples a few locks from the other 3 or 4 lots into which the 100-boll sample had been divided.

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[6] In 1 instance replicates were composited, making 767 samples rather than 768 ($16 \times 2 \times 8 \times 3$). To facilitate analysis and to have equal numbers of observations, the data obtained from the composited sample were assigned to the 2 replications.

In collecting the material for the special-planting samples the burs were snapped, the locks thus being left intact. The regional variety samples, on the other hand, consisted of picked cotton. With the latter type of sample there is some possibility that basally located seeds and motes may be left in the bur. In selecting the 100-lock samples, only those locks that appeared to be intact were included.

Observations for the special-planting samples and the 100-lock samples were recorded on a lock basis. For each lock the type of boll (4- or 5-lock) from which it came, number of ovules represented, and the type and position of each mote were noted. This method of recording made it possible not only to determine for each sample the total number of seeds and motes but to group the data so that similar information could be obtained on the basis of lock size, number of locks per boll, and number of motes per lock.

For each 1,000-seed-and-mote sample of the spinning test series only data as to the number of motes of each type were taken.

The number of motes in each of the samples representing the different varieties, locations, years of growth, blooming dates, lock sizes, and boll sizes is expressed by a percentage figure based on the number of motes present as related to the total number of ovules represented. These values are termed for the sake of convenience "mote percentages," though each is in reality the percentage of ovules that failed to ripen into mature seeds. In describing hereafter the size of the samples on which these values are based the term "seed" is used for the sake of simplicity to include both seeds and motes. For example, a sample is described as being composed of 1,000 seeds or as being a 1,000-seed sample, the figure actually referring to the number of potential seeds, or ovules, represented and thus including both seeds and motes.

For certain of the lock-size and boll-size samples the percentages of locks with no motes were calculated.

Information regarding the distribution of motes within locks was obtained as follows: The positions in the lock were numbered, in general, according to the method described by Rea (*16*). The apical position was designated as 1 and those below it, but on the same side, as 3, 5, 7, 9, and so forth successively down the lock, while the positions on the opposite side were numbered 2, 4, 6, 8, 10, and so forth. The apical seed can be readily recognized in locks with an odd number of seeds, but some difficulty may be encountered with locks having an even number of seeds or a mote at the apical position. If the bur is available, the funicular scars can be of assistance in ascertaining which seed is the apical one. Usually, however, if a lock is gently pulled at both ends, the staggered arrangement becomes evident and the position of each seed or mote can be recognized. With locks having an odd number of seeds there may be some difficulty in ascertaining to which row the apical seed belongs. If the bur is not available its correct position can usually be established by noting the direction of the raphe in relation to an imaginary line running from base to tip of the lock between the two rows of seeds.

The mote-position data for each variety were grouped according to lock size. Each lock-size group was subdivided according to the number of either large or small motes present. Thus for each size of lock there are subsamples of 1, 2, 3, 4, and 4+ small motes and 1, 2, 3, 4, and

4+ large motes per lock. Locks with both mote types present were disregarded.

The percentage of motes at each position was calculated for each lock-size, mote-number subsample, the percentages being based on the number of motes found at each position in relation to the number of motes in the entire subsample. This method of calculating position data is similar to that used by Porter (*15*) but different from that employed by Afzal (*1*), Afzal and Trought (*2*), and Rea (*16*). The percentage values presented by the last three investigators are based on the number of motes in relation to the total number of seeds and motes occurring at a certain position for any particular sample. Trends could be shown equally well by values derived by either method. Varietal differences in the total number of motes produced, however, would influence the size of the percentage figures if they are calculated by the method used by Afzal (*1*), Afzal and Trought (*2*), and Rea (*16*), but would have no effect upon the results when calculations are made according to the method used in this study.

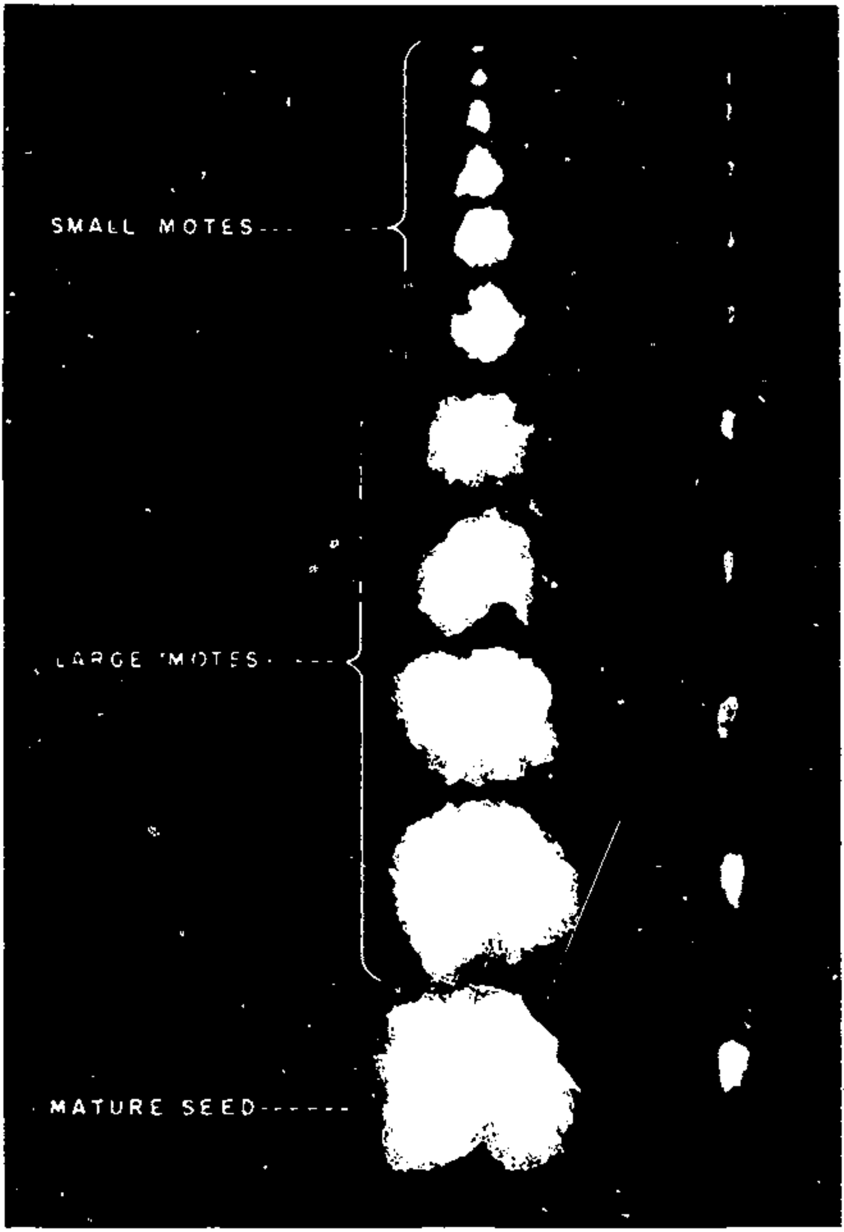
The subsamples were not of equal size, but all samples considered herein contained at least 100 motes, unless otherwise indicated. Most samples contained several hundred. In a few instances, especially in the case of large motes, it was necessary to group varieties in order to obtain 100-mote samples.

MOTE TYPES AND CLASSIFICATION

In this study the term "mote" is used to designate those structures in seed cotton that are derived from ovules but that show evidence of arrested development and thus cannot be classed as mature seeds. These structures vary in size, and the different sizes for any one variety form a graduated series beginning with tiny structures having few or no fibers and ending with other structures that differ little from mature seeds (fig. 1). This range in size would suggest that the checking of development might occur at various stages or perhaps at any stage in seed development, beginning with the day of flowering. The factors concerned are undoubtedly many.

There is no consistent or precise definition for motes in the literature dealing with these structures. Motes have been described as "immature seeds" (*9*), "aborted ovules" (*2*, *16*), and "aborted seeds" (*15*). One of the dictionary definitions for a mote is an "undeveloped seed" (*19*). "Immature" implies some considerable degree of development and could not logically be applied to the very smallest motes. Since an ovule may be defined as a "young seed" (*7, p. 261*) and abortion as the "arrest of development of any organ" (*19*), either "aborted ovule" or "aborted seed" might be used to define a mote. However, "aborted ovule" could mean that the ovule itself on the day of flowering was defective, and it is questionable whether the definition would be appropriate for those very large motes that might be called immature seeds. "Undeveloped seed" is not entirely satisfactory, since the definition does not imply the extreme range in size and degree of development which "motes," as the term is used in this report, exhibit.

Of the four definitions, "aborted seed" is preferred. It is true that "aborted seed" might imply some small degree of development of the ovule into a seed, or at least fertilization, and thus there might be some



F[illegible] Motes and a mature seed, with and without long fibers, of one variety [illegible] objection to applying the definition to small motes formed from ovules that received no pollen tubes. Nevertheless, since, as was stated previously, the arresting of development, or abortion, of the young seed may occur probably at any stage during seed development beginning with the day of flowering, all structures, regardless of size or causal factors, resulting from those ovules, or young seeds, that fail to reach maturity may be then appropriately called aborted seeds.

The use of the term "mote" to designate an aborted seed, however, is unfortunate because the term has also been applied by cotton ginners and manufacturers to small bits of seed coat with attached fibers (*11*, *19*). The term, however, has been used to designate the aborted structures in seed cotton too extensively in the literature to consider discontinuance of its use in this sense. If the term "mote" when applied to cotton is restricted to seed cotton and used as it is in this discussion to include those structures of ovular origin that show evidences of arrested development, confusion will be avoided.

Porter (*15*) presented a classification in which motes are "classified according to the degree of maturity of the seeds as indicated by their relative sizes and their length of lint in comparison with the remainder of those in the lock . . ." (*p. 6*). He made five size classes. The author originally attempted a similar classification, making four classes. Such classifications are complicated by the fact that cottons differ in seed size, length of fiber, amount of fuzz, and density of fiber population on the seed. Moreover, the division of such a series as that shown in figure 1 into several small classes merely on the basis of size differences is meaningless. To make a classification useful and meaningful, the division lines between classes should represent relations of some kind, such as perhaps causal factors or cotton-quality relations.

In spite of the limited knowledge concerning the precise reasons why certain young seeds fail to mature, it is apparent that at least two or three rather general factors are responsible for mote formation. Some motes are very obviously due to insect injury, particularly the injury caused by boll-sucking insects (*10*). Other motes are probably due to attacks by micro-organisms. But there are many motes whose formation is more obscure, for they are found in bolls apparently free from disease caused by micro-organisms and from insect injury, their occurrence and abundance apparently being due to the action of genetic and environmental factors. It is this group that is usually being considered when motes are discussed, and it is with this group that the greater part of this bulletin is concerned.

It is possible to divide the motes whose formation is apparently the result of genetic and environmental influences into two rather distinct classes, the division being based for the most part on differences in general appearance; the division also represents differences in the types of small imperfections produced and probably in causal factors as well. These two classes are designated simply "small motes" and "large motes" (fig. 1).

The small motes include all those whose seed body has undergone little enlargement and whose fibers are short and give the general appearance of being thick-walled (not silky). The fibers appear to be similar to those on mature seeds except that they are shorter. It is of interest that the longest fibers on these small motes are not located at the chalazal end as are those on mature seeds, but on the micropylar half (fig. 1). This distribution is to be expected, however, for the little differentiation and development of seed-coat tissue that does occur takes place in the micropylar portion.[7]

There is one particular type of small mote which, though not of frequent occurrence, is distinctly different from the others. The motes of this particular type are located toward the outer surface of the lock (fig. 2); examination of unopened bolls shows that, unlike motes of other types, they are not attached to the placenta. Moreover, they differ from other small motes occurring in apparently healthy

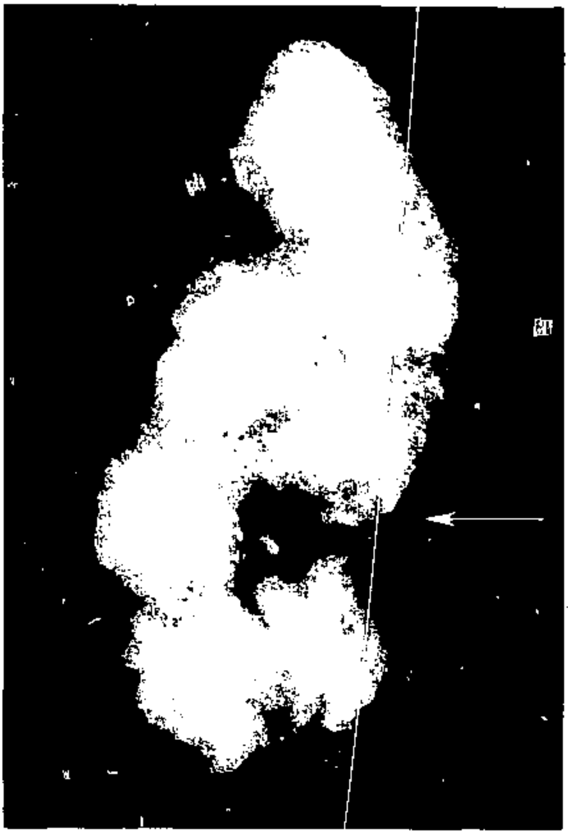


FIGURE 2. —Lock of cotton showing "disconnected mote," indicated by arrow. × 1.

bolls in that their fibers are brownish. For lack of a better term they are called "disconnected motes," but they are classed herein with the other small motes. Usually there is only one such mote in a lock, but occasionally two or more were found. If only one is present, it occupies the third position from the base in the majority of cases.

The very small size of the disconnected motes seems to indicate that their connection with the placenta was broken very early in boll development. These structures might have become motes even if they had

[7] Unpublished information.

remained attached to the placenta; it is possible that they become detached because of the more rapid growth of the surrounding seeds.

The motes classified as large have a larger seedlike body than do the small ones (fig. 1). The fibers, too, are longer, and they are usually thin-walled and thus have a silky appearance. The seed coat is lighter in color than that of the small motes or of mature seeds and can be easily crushed between the thumb and the forefinger. The remains of an embryo may or may not be present.[8]

As stated previously, motes are one of the sources of neps and seed-coat fragments—those small imperfections that are so troublesome to cotton-yarn manufacturers. The small imperfections arising from large motes are, however, distinctly different from those arising from small ones. Both mote classes yield fragments that may persist into the yarn, appearing there as undesirable specks which lower the quality (*11*). The fragments from large motes, however, present different dyeing problems than do those from small motes. The fibers on the former are largely thin-walled and, therefore, would tend to dye differently from the thick-walled fibers on fragments from small motes (*11*).

It is doubtful whether small motes play a part in nep formation. Large motes, however, are undoubtedly an important source of nep-forming fibers (*11, 12*). The fibers of many of these motes are sufficiently long to be ginned and these long, thin-walled fibers when added to the lint are a potential source of neps (*11, 12*).

It is true that the dividing line between large and small motes is not a clean-cut one and that motes occur that are difficult to classify. However, the number of border-line cases in any one sample is usually small and to classify them with either group would ordinarily have no appreciable effect upon the final percentages.

Any mote classification poses the additional problem of distinguishing very large motes from mature seeds. Since there appear to be all gradations in development of seed coats, fibers, and embryos, a sharp dividing line is impossible. Nevertheless, it is necessary for analytical purposes that a basis be established for classifying a structure either as a large mote or as a mature seed. In this study a seemingly border-line case was considered a large mote if it possessed all three of the following characteristics: Its fibers, though long, were silky or thin-walled; its seed coat was easily crushed and was lighter in color than that of a normal mature seed; and its embryo gave evidence of arrested development. If the structure in question possessed only one or two of these characteristics and appeared as a mature seed with regard to the other one or two, it was considered a mature seed and not a large mote.

Insect injury and the factors concerning it were not studied in detail though some general observations were made concerning injury due to boll-sucking insects (*10*).[9] It was apparent that bolls could be attacked

[8] Studies made by Gladys F. West, assistant botanist, Division of Cotton and Other Fiber Crops and Diseases, Raleigh, N. C., indicate that some large motes possess no embryos. (Unpublished information.)

[9] Appreciation is expressed to E. W. Dunnam, Division of Cotton Insect Investigations, Bureau of Entomology and Plant Quarantine, Agricultural Research Administration, Delta Branch Experiment Station, Stoneville, Miss., for pointing out the probable importance of injury due to boll-sucking insects in mote formation.

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by these insects at all stages of development, at least up to the age at which the boll wall begins to harden. A growth on the inside of the carpel wall is formed at the point of puncture by the insect's proboscis (*10*); and the majority of motes close to these growths are undoubtedly formed as a result of insect feeding, although it is of course possible that motes due to other causes may by chance be located in the same vicinity. The growths formed on the carpel wall are in most cases so pronounced that they are still evident on the dried burs (fig. 3, *A*), and, when locks are left in the bur, are of value in identifying those motes which are probably formed as a result of injury from boll-sucking insects.

When very small bolls are attacked usually an entire lock, and frequently the entire boll, is affected. The motes formed are small, and the fibers are usually rather yellowish (fungal or bacterial infection?) and have a silky appearance. These small insect-induced motes will ordinarily offer no identification problem in picked cotton, for in most instances the injured locks are not extracted from the bur.

When larger bolls are attacked by boll-sucking insects, in general only one or two seeds of a lock are injured. There is usually some slight discoloration of the fibers very close to if not directly beneath the growth on the carpel wall, indicating the place of insect puncture (*10*). Aside from this, sometimes very slight, discoloration, these motes do not differ macroscopically from motes of similar size found in apparently healthy bolls. Consequently, in picked cotton, large motes due to boll-sucking-insect injury cannot always be identified as such.

It is possible that some motes are formed as a result of infection by micro-organisms. Indeed, it is possible that many motes, particularly the large ones in seemingly disease-free bolls, may be due to a diseased condition of the plant.

In some instances large motes have been observed to be associated with a distorted, enlarged, and occasionally discolored condition of the funiculus and placenta (fig. 3, *C* and *D*; compare *D* with *E*). It is not known to what this enlargement is due. In this study, the motes associated with this distortion have not been considered as comprising a separate group, since they could not be recognized with certainty in the picked-cotton samples.

There are associated with many locks of cotton small motelike bodies which should be recognized as being distinct from true motes. These particular structures are similar to the very smallest motes in that each consists of a very small central body to which short fibers are attached. They differ from small motes in that they are not derived from ovules but from rudimentary yet somewhat ovulelike bodies, each of which is located just below and between the two basal ovules of a carpel. These basal bodies and the false motes to which they give rise are described elsewhere (*13*).

The classification of motes given herein is summarized briefly as follows: Motes of cotton may be divided on the basis of rather general causal factors into two main groups: (1) Insect- and disease-induced motes (obviously due to insect injury and disease caused by micro-organisms) and (2) genetically and environmentally induced motes. This latter is the group with which this report is particularly concerned. The group has been divided into two classes (large motes

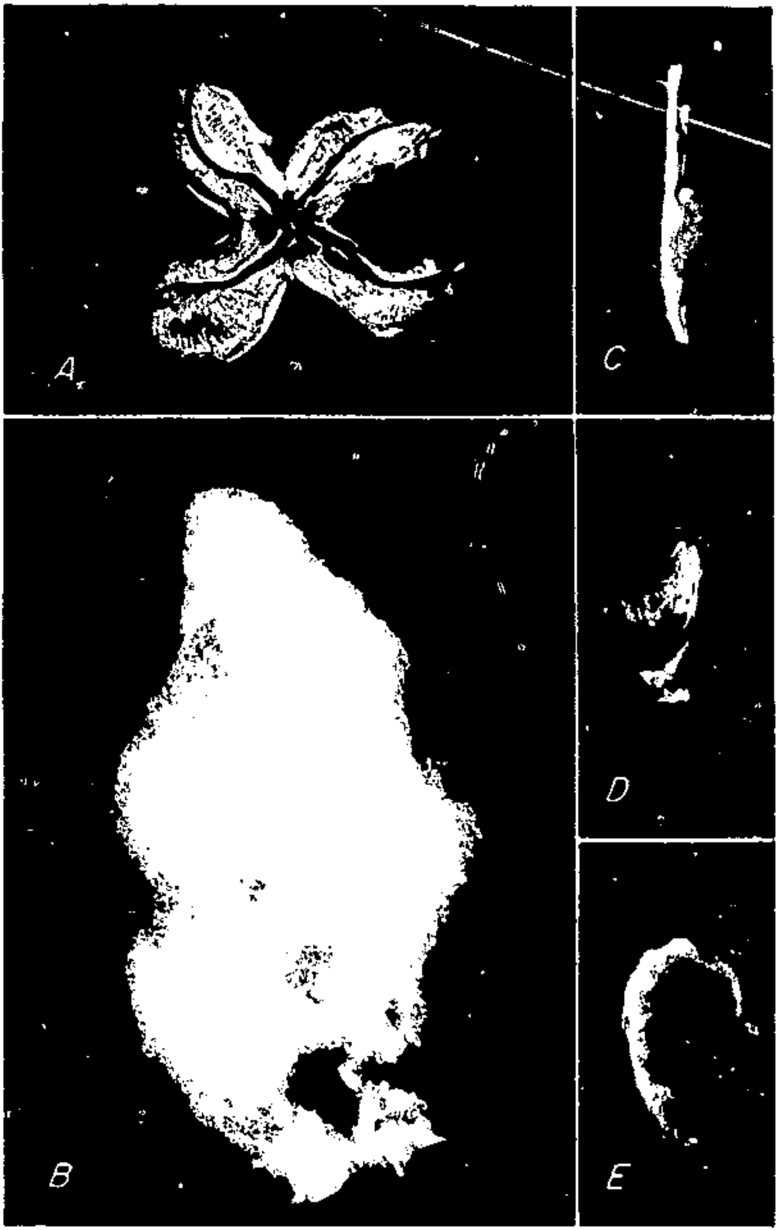

FIGURE 3.—*A*, Bur showing growths on capsule walls resulting from boll-sucking-insect injury. × 1. *B*, Lock showing three motes at the base formed probably as a result of boll-sucking-insect injury. × 1. *C*, Placental tissue from one locule of a nearly mature, unopened boll showing swollen condition. × 2. *D*, Large mote that was attached to the swollen region shown in *C* with fibers removed; note enlarged funiculus. × 2. *E*, Normal seed from the same locule as mote shown in *D*, with fibers removed. × 2.

TABLE 1.—*Motes produced by 2 series for each of 16 varieties of cotton grown at 8 locations in 3 successive years* [1]

Mote type and variety	Motes produced at indicated location and in indicated year											Mean
	Location								Year			
	Florence, S. C.	Stoneville, Miss.	Marianna, Ark.		Baton Rouge, La.	Stillwater, Okla.	College Station, Tex.	Lubbock, Tex.	1935	1936	1937	
			Upland	Delta								
Small motes [2]	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Acala (Rogers)	12.3	12.2	10.1	10.1	8.8	19.3	11.5	11.8	12.1	12.9	11.0	12.0
Arkansas 17	6.8	9.2	7.7	8.6	5.3	13.1	7.6	7.7	8.3	8.8	7.6	8.2
Cleveland (Wannamaker)	8.2	11.1	11.8	10.3	8.7	14.4	10.6	10.4	9.9	12.1	10.1	10.7
Cook 912	8.0	10.4	8.9	9.5	6.0	15.4	7.8	9.5	9.4	10.9	8.0	9.4
Delfos (Missdel) 4	8.7	9.9	8.8	10.3	7.0	17.2	8.4	10.0	8.7	11.7	9.6	10.0
Deltapine 11	7.9	8.5	7.1	7.3	5.6	11.7	6.6	7.0	7.3	8.0	7.8	7.7
Dixie Triumph 759	6.1	9.8	8.3	9.4	5.7	12.4	7.4	6.8	7.8	9.1	7.8	8.2
Farm Relief 2	8.6	13.0	10.3	10.0	7.8	15.0	8.9	10.2	10.5	11.2	9.8	10.5
Half and Half	13.9	16.9	14.4	15.5	10.0	18.3	15.0	13.2	14.7	14.8	14.4	14.6
Mexican Big Boll	7.6	7.5	8.1	7.6	5.7	11.2	7.2	6.9	7.8	8.3	7.1	7.7
Qualla	10.6	13.9	11.6	10.3	7.9	15.6	13.4	10.9	11.7	12.3	11.3	11.8
Rowden 40-2088	7.4	10.2	7.9	7.8	5.6	11.6	7.5	7.6	7.6	9.0	8.0	8.2
Startex 619	8.4	11.4	11.1	9.9	6.9	14.9	9.2	9.0	9.7	11.2	9.5	10.1
Stoneville 5	8.0	9.4	9.5	10.0	7.5	15.3	8.6	10.3	9.4	11.1	9.0	9.8
Triumph (Oklahoma) 44	7.0	8.8	9.0	8.4	6.0	12.6	7.6	6.7	7.7	8.9	8.2	8.3
Wilds 5	9.4	12.1	10.2	11.4	9.1	16.7	9.7	13.0	11.4	11.8	11.1	11.4
Mean	8.7	10.9	9.7	9.8	7.1	14.7	9.2	9.4	9.6	10.8	9.4	9.9

Large motes [2]												
Acala (Rogers)	3. 6	3. 4	3. 6	3. 3	4. 5	4. 2	3. 6	2. 2	3. 6	3. 2	3. 9	3. 6
Arkansas 17	2. 5	2. 6	2. 6	1. 8	3. 1	4. 2	2. 0	2. 1	2. 8	2. 0	3. 0	2. 6
Cleveland (Wannamaker)	2. 5	2. 1	2. 4	1. 3	3. 2	3. 6	2. 2	1. 3	2. 4	1. 6	3. 0	2. 3
Cook 912	2. 4	2. 3	2. 1	1. 3	2. 5	3. 4	2. 2	1. 3	2. 3	1. 4	2. 8	2. 2
Delfos (Missdel) 4	2. 6	2. 2	2. 8	1. 6	3. 0	3. 2	2. 8	1. 6	2. 8	1. 8	2. 8	2. 5
Deltapine 11	3. 3	2. 3	3. 0	1. 1	3. 4	3. 2	2. 2	1. 3	2. 5	1. 9	3. 0	2. 5
Dixie Triumph 759	3. 2	2. 2	2. 4	1. 3	2. 6	4. 1	2. 7	1. 4	2. 6	1. 8	3. 0	2. 5
Farm Relief 2	4. 3	3. 7	4. 0	3. 1	4. 2	5. 6	3. 6	2. 1	3. 7	3. 7	4. 1	3. 8
Half and Half	3. 3	2. 0	2. 8	1. 3	3. 6	3. 1	2. 8	1. 7	2. 4	2. 1	3. 2	2. 6
Mexican Big Boll	4. 9	3. 4	3. 8	3. 1	4. 7	4. 7	3. 4	2. 8	4. 2	3. 4	4. 0	3. 8
Qualla	3. 3	2. 5	2. 6	2. 3	3. 9	4. 1	3. 2	1. 3	2. 8	3. 1	3. 8	2. 9
Rowden 40–2088	3. 1	2. 6	3. 2	2. 0	3. 2	4. 4	2. 9	1. 7	3. 0	2. 5	3. 2	2. 9
Startex 619	2. 8	2. 2	2. 2	1. 3	2. 8	4. 2	2. 6	1. 2	2. 7	1. 8	2. 8	2. 4
Stoneville 5	3. 0	2. 2	1. 5	1. 1	2. 3	3. 6	2. 1	1. 0	2. 6	1. 6	2. 1	2. 1
Triumph (Oklahoma) 44	3. 1	3. 4	2. 7	1. 8	3. 9	3. 9	3. 3	2. 2	2. 2	2. 2	3. 7	3. 0
Wilds 5	4. 6	3. 1	3. 7	2. 6	3. 7	5. 7	3. 4	2. 2	3. 7	2. 8	4. 3	3. 6
Mean	3. 3	2. 6	2. 8	1. 9	3. 4	4. 1	2. 8	1. 7	3. 0	2. 2	3. 3	2. 8

[1] Number of observations on which mean values are based are as follows: Varieties, 48; locations, 96; years, 256; varieties at different locations, 6; varieties in different years, 16. One observation is the percentage of either small or large motes in a 1,000-seed sample.

[2] Least significant difference between—

	Small motes		Large motes	
	5-percent level	*1-percent level*	*5-percent level*	*1-percent level*
Variety means	0. 58	0. 76	0. 25	0. 33
Location means	. 41	. 54	. 18	. 23
Year means	. 25	. 33	. 11	. 14

and small motes), the division being based principally on size and general appearance, but to a certain extent also on the characteristics of the small imperfections to which they may give rise.

VARIATION IN OCCURRENCE OF MOTES

Variation With Variety

Varieties differ strikingly in their tendencies to form motes (tables 1 and 2). For the 16 varieties grown at 8 locations for 3 successive years, the average values representing small-mote formation ranged from 7.7 to 14.6 percent. A difference of only 0.76 percent is required for significance at the 1-percent level, which means that Deltapine 11 and Mexican Big Boll produced significantly fewer small motes than 10 of the other varieties and that Half and Half produced significantly more than all the others.

Table 2.—*Variance analysis of the percentages of motes in 767 samples of 1,000 seeds each representing 2 series for each of 16 varieties of cotton grown at 8 locations in 3 successive years*

Source of variation	Degrees of freedom	Mean square for—	
		Small motes	Large motes
Varieties	15	175. 21**	16. 32**
Locations	7	464. 68**	58. 11**
Years	2	137. 28**	73. 91**
Blocks within locations	8	2. 82	. 57
Varieties × locations	105	5. 23**	. 74**
Varieties × years	30	3. 99**	1. 05**
Locations × years	14	128. 36**	25. 53**
Blocks within locations × years	16	2. 56	1. 00*
Years × locations × varieties	210	2. 81*	. 76**
Error	359	2. 05	. 39
Total	[1] 766	13. 07	2. 07

*Significant at the 5-percent level.
**Significant at the 1-percent level.
[1] In 1 instance, replicates were composited, thus reducing degrees of freedom from 767 to 766. In order to facilitate analysis and make equal numbers of observations, the percentage figure of the composited sample was assigned to the 2 replications.

These 16 varieties produced fewer large than small motes. The percentage values representing large-mote formation ranged from 2.1 percent for Stoneville 5 to 3.8 percent for Mexican Big Boll and Farm Relief 2. A difference of 0.33 percent is required for significance at the 1-percent level. Thus Stoneville 5 produced significantly fewer large motes than 12 of the other varieties and Mexican Big Boll and Farm Relief 2 significantly more than 12 of them (table 1). Under certain conditions it would be desirable to include the large motes due to insect injury, for these are just as important as the genetically and environmentally induced ones from the standpoint of the production of small imperfections in yarn. If motes presumed to have resulted from boll-sucking-insect injury are included, the percentage values for large motes are raised to 3.6 percent for Stoneville 5, 5.9 percent for Mexican Big Boll, and 6.2 percent for Farm Relief 2.

Among these varieties the production of one type of mote was not found to be consistently related to the production of the other type (table 1). For example, both Acala (Rogers) and Wilds 5 tended to produce relatively large numbers of both large and small motes. On the other hand, Half and Half produced a relatively large number of small motes but comparatively few large ones, while in the case of Mexican Big Boll the situation was just the reverse.

The importance of variety in mote formation is further shown by the disconnected motes. These peculiar small motes were found to occur with much greater frequency in certain varieties than in others (table 3).

Table 3.—*Disconnected motes produced by varieties of cotton grown at 2 locations in 1937*

Variety	Disconnected motes produced at indicated location	
	Stoneville, Miss.[1]	Statesville, N. C.[2]
	Percent	*Percent*
Acala (Rogers)	1.37	1.60
Acala (Slick-Seeded)	.08	----------
Arkansas 17	.05	.03
Cleveland (Wannamaker)	.07	.23
Cook 912	.08	.11
Delfos (Missdel) 4	.03	.04
Deltapine 11	.05	.13
Dixie Triumph 759	.06	.13
Farm Relief 2	.02	.14
Half and Half	.48	.53
Mexican Big Boll	.44	.32
Qualla	.68	1.14
Rowden 40–2088	.23	.66
Startex 619	.18	.57
Stoneville 5	.25	.26
Triumph (Oklahoma) 44	.00	.18
Wilds 5	.02	.12

[1] Special-planting samples, set I; each value is based on variety samples ranging in size from 11,574 seeds (413 bolls) to 23,026 seeds (637 bolls).
[2] Regional variety samples; each value is based on samples ranging in size from 12,935 to 14,813 seeds (1,600 locks).

There was a highly significant tendency for the varieties to exhibit a differential response to the effect of factors varying with both location and year of growth (table 2). Nevertheless, no matter where or when the cottons were grown, the varieties tended to retain about the same relation to one another with regard to the relative number of motes of each type produced (tables 1 and 2).

That varieties differ in their mote-forming tendencies was observed by Afzal (*1*), Afzal and Trought (*2*), Porter (*15*), and Rea (*17*).

It is not to be expected that the mote percentage figures presented by these investigators would be comparable with those presented in this study, since the varieties used and the environments under which they make their experiments were different. However, in some instances these values appear on the whole to be rather high. A partial explanation may be that they probably are based on all the motes (large, small, insect-induced, and disease-induced) present in a sample, including undoubtedly the basally located false motes. These probable sources of discrepancy should be borne in mind when the results of Afzal, Afzal and Trought, Porter, and Rea are being discussed.

Variation With Environment

The importance of environmental factors in mote formation was shown by the variation in the relative number of motes formed by 16 varieties when grown at 8 different locations (locational effects) and in 3 different years (seasonal effects, which would be meteorological in nature). Highly significant differences were found in the mote content of samples representing different locations and different years (tables 2 and 4). In fact the amount of variance in the data attributable to environmental factors was greater than that attributable to varietal ones. For the data as a whole, locational effects were much more important than seasonal ones in their influence upon the formation of small motes, while in the case of large motes seasonal effects exceeded in importance those associated with place of growth.

The importance of seasonal factors is further shown by the differences from year to year at the same location. In the case of large motes there is no tendency for location rank to be the same from year to year. In the case of small motes, however, seasonal factors are apparently not so effective for there is some slight tendency (significant at the 5-percent level) for location rank to be about the same from year to year. For example, Stillwater, Okla., ranked highest in small-mote production in all 3 years, while Baton Rouge, La., ranked lowest. Stoneville, Miss., tended to be above the average. Other locations such as Florence, S. C., were very inconsistent (table 4).

The results of the analysis give definite indications that at least some of the factors responsible for the formation of small motes are different from those responsible for the formation of large ones; it may be concluded that variety is a greater factor in small-mote than in large-mote formation and that seasonal factors are of greater importance in the formation of large than small motes.

Since the results of the analysis point so clearly to the importance of seasonal factors in mote formation, an attempt was made to relate the yearly differences in motes formed at each location to rainfall and temperature differences. The large number of motes produced at Stillwater, Okla., in 1936 could be attributed to the extreme drought of that year, but consistent relations with rainfall or temperature at other locations could not be demonstrated. It is true, however, that the differences between years at any one location in the percentages of motes formed were not very large, yet some were large enough to be considered statistically significant. The failure to establish consistent relations for these differences may result from a failure to consider some factors other than rainfall and temperature or from incorrect interpretation or use of the data available.

TABLE 4.—*Motes produced at 8 locations by 2 series of each of 16 varieties of cotton grown in 3 successive years* [1]

Mote type and location	Motes produced in indicated year			Mean
	1935	1936	1937	
Small motes: [2]	*Percent*	*Percent*	*Percent*	*Percent*
Florence, S. C.	7.5	8.2	10.3	8.7
Stoneville, Miss.	10.7	11.8	10.2	10.9
Marianna, Ark. (upland)	9.0	9.7	10.3	9.7
Marianna, Ark. (delta)	9.9	11.3	8.1	9.8
Baton Rouge, La.	6.0	7.3	8.0	7.1
Stillwater, Okla.	13.6	20.0	10.4	14.7
College Station, Tex.	10.0	8.1	9.5	9.2
Lubbock, Tex.	10.2	9.6	8.6	9.4
Mean	9.6	10.8	9.4	9.9
Large motes:				
Florence, S. C.	4.4	3.0	2.4	3.2
Stoneville, Miss.	2.9	1.9	3.1	2.6
Marianna, Ark. (upland)	2.6	2.7	3.2	2.8
Marianna, Ark. (delta)	2.7	1.1	1.9	1.9
Baton Rouge, La.	2.9	2.3	5.0	3.4
Stillwater, Okla.	3.2	4.0	5.0	4.1
College Station, Tex.	2.6	1.4	4.5	2.8
Lubbock, Tex.	2.3	1.6	1.2	1.7
Mean	3.0	2.2	3.3	2.8

[1] Number of observations on which mean values are based are as follows: Locations, 96; years, 256; locations in different years, 32. One observation is the percentage of either small or large motes in a 1,000-seed sample.

[2] Least significant difference between—	Small motes, 5-percent level	Small motes, 1-percent level	Large motes, 5-percent level	Large motes, 1-percent level
Year means	0.25	0.33	0.11	0.14
Location means	.41	.54	.18	.23

Further evidence as to the effect of meteorological factors on mote formation was obtained from a study of the differences in the percentage of motes in the seed cotton of bolls from successive days of flowering as shown by varieties grown at Stoneville, Miss., in 1937 and 1939 (special-planting samples, set II). An attempt was made to relate mote-percentage differences to daily fluctuations in humidity, rainfall, and temperature. Each year a record was kept of the time and amount, in general terms, of the rain that fell on the plot where the cotton varieties were growing. Data on the exact amounts of precipitation were from the United States Weather Bureau records. In a few instances the showers that fell on the cotton plot were of very limited extent and so were not included in the record for the Stoneville station. Temperature and humidity data are for Greenville, Miss., which is very close to Stoneville, Miss., and are also taken from the United States Weather Bureau records. Temperature information for the Stoneville station was available only for 1939; since this record corresponded very closely to the Greenville record, the conditions at the latter were used for both years.

Considerable variation in the percentage of motes, particularly small ones, was found in bolls representing the daily sequence of blooms (figs. 4 and 5). There are, however, in each year certain peaks, trends, or periods which are fairly consistent for all varieties. Some of the peaks coincide with days on which there was rainfall and others with days or periods of exceedingly high temperature.

It is reasonably certain that rain during the time of pollination, and even that falling shortly thereafter, affects the number of ovules receiving pollen tubes by interfering either with pollen deposition on the stigma or with pollen-tube growth. The ovules failing to receive pollen tubes would develop into small motes. Under ordinary conditions at Stoneville, Miss., the stigmatic surface is receptive and the

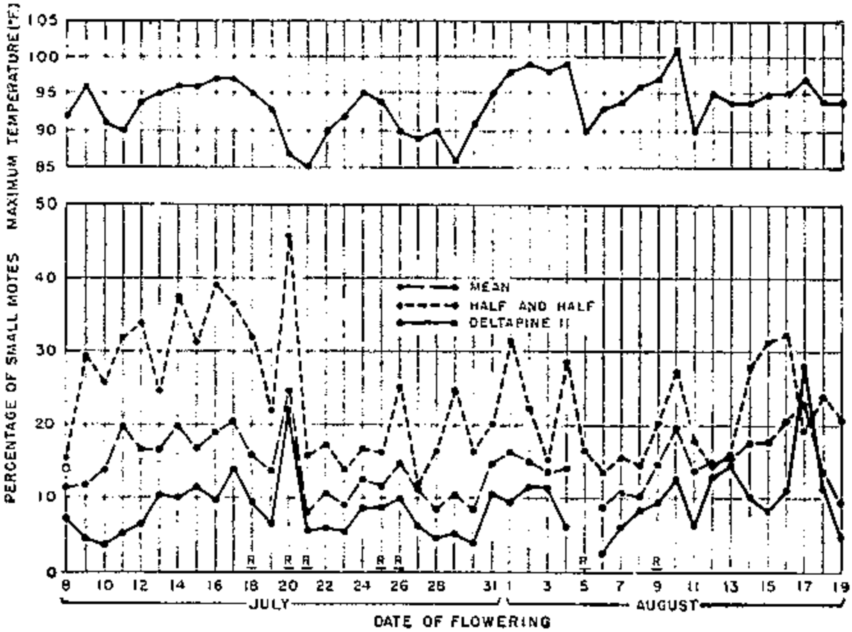

FIGURE 4.—Percentages of small motes in seed cotton produced from successive days of flowering for the mean and 2 extremes of 6 varieties grown at Stoneville, Miss., in 1937, together with the maximum daily temperatures (for Greenville, Miss.). Each varietal observation based on samples ranging in size from 5 to 91 bolls except that indicated by ○, which contained only 4 bolls. No means were computed for August 5, for several varieties did not yield samples of at least 5 bolls. Days on which rain fell between 8:00 a. m. and 5:00 p. m. (R). The time and amount are as follows:

Date:	*Time*	*Amount (Inch)*
July 18	1:20+	0.12
July 20	8:00-2:30	.67
July 21	12:45+	.04
July 25	2:30+	.39
July 26	8:00-12:00	.15
Aug. 5	8:45-3:00	.30
Aug. 9	9:00++; 9:45++; 10:30++	

+, Rain of short duration. ++, Rain of short duration and in limited areas; no station record.

anthers are open from about 9 a. m. to 12 m., but artificial pollinations in the early afternoon following a rainy or cold morning with pollen from bagged flowers are usually successful.[10] The hours between 8 a. m. and 5 p. m. were set as the extreme limits of the time during which it was thought rainfall might do material damage to pollen deposition and tube development. It is true that there are inconsistencies in the data when the varieties are considered separately, but, in general and especially when the means for all varieties are considered, the bolls for days on which considerable rain fell before noon had relatively more small motes than bolls for the days immediately preceding and immediately following (figs. 4 and 5). The rain on some of the days apparently came too late in the day or was too light to interfere seriously with pollen-tube development. The rains of August

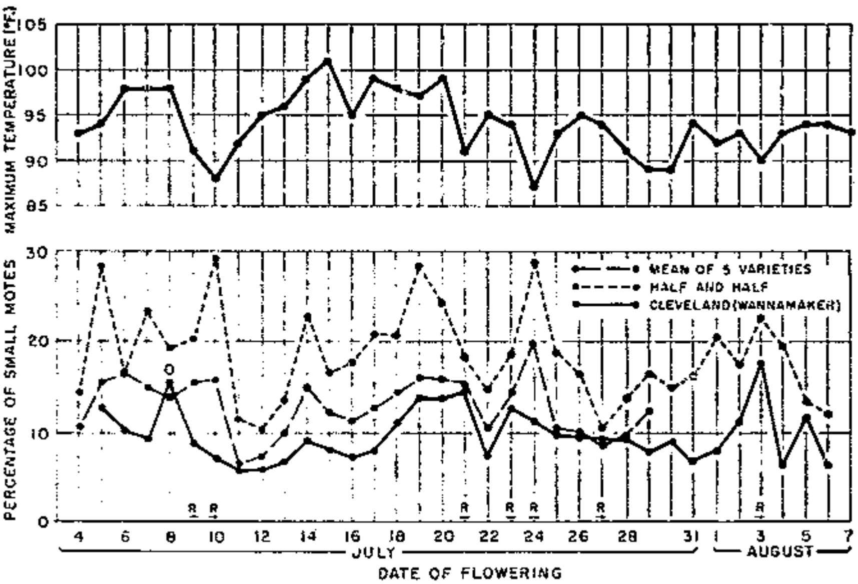

FIGURE 5.—Percentages of small motes in seed cotton produced from successive days of flowering for the mean and 2 extremes of 5 varieties grown at Stoneville, Miss., in 1939, together with the maximum daily temperatures (for Greenville, Miss.). Each varietal observation based on samples ranging in size from 5 to 112 bolls except that indicated by ○, which contained only 3 bolls. No means were computed for days after August 29, for 1 or more of the varieties did not yield samples of at least 5 bolls. Days on which rain fell between 8:00 a. m. and 5:00 p. m. (R). The time and amount are as follows:

Date:	*Time*	*Amount (inch)*
July 9	12:00–1:00; 3:00–5:00	0.23
July 10	11:00–12:00; 3:30+	.06
July 21	8:30–9:00; 11:00+	.31
July 23	9:30–10:00; 2:00–5:00	.61
July 24	11:20–1:00++	
July 27	2:14–5:00++	
Aug. 3	8:00–11:00	.51

+, Rain of short duration. ++, Rain of short duration and in limited areas; no station record.

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[10] Observations by J. W. Neely, geneticist, formerly of the Division of Cotton and Other Fiber Crops and Diseases.

5, 1937, and August 3, 1939, not only came during the critical period but were also sufficiently heavy to have a marked influence on the number of bolls set. For the first date a total of 13 bolls was set as compared with 182 for August 4 and 233 for August 6. For August 3, 13 bolls were set as compared with 80 for August 2 and 48 for August 4.

For the crop as a whole, it is probable that a large percentage of small motes in bolls from rainy-day blooms is of relatively little importance. The amount of shedding for days on which a heavy rain occurs during the forenoon would usually be so extensive that a large mote production for the relatively few bolls matured would have little influence on the total mote content of the entire crop.

The temperature of the day on which a flower blooms appears to have a very pronounced effect on the relative number of ovules which will form motes. In 1937 there were four very definite periods several days in length, during each of which there was an increase in maximum daily temperature, the peak of which was followed by a general decrease (July 11–21, July 21–29, July 29–August 5, and August 5–11; fig. 4). If the bolls that developed from flowers that bloomed on rainy days are left out of consideration, those that correspond to the sequence of days in each period tend to show an increase or a decrease in small-mote formation following in general the temperature trend.

In 1939 there were only two clearly defined periods in which there was a rather gradual increase in maximum daily temperature for a few days, the peak then being followed by a decline (July 4–10 and July 10–24, fig. 5). If the rainy days are not considered the varieties show a trend in small-mote production corresponding in general to the temperature trend during these two periods.

It is probable that the maximum daily temperatures have a much greater influence on the percentage of small motes in a crop of cotton than does rain which falls during the hours when pollination ordinarily would take place, for high temperatures alone, at least for the particular cotton varieties grown at Stoneville, Miss., in 1937 and 1939, were not found to be associated with extensive boll shedding.

It was not demonstrated that the relative humidity of the atmosphere on rain-free days was a factor in the formation of small motes.

The formation of large motes did not appear to be related to conditions prevailing on the day of flowering. This, of course, would be expected, since the degree of development attained by these structures would indicate that their formation was due to the effect of factors operating after considerable seed development had taken place.

Data from the special-planting samples, set II, were further examined to ascertain whether a seasonal trend in mote formation could be established. No consistent differences were observed in the small-mote content of bolls representing early, middle, and late parts of the blooming period. In 1937 there was a slight tendency for the bolls from early and late blooms to show more small motes than those from the midseason blooms. No such tendency was shown in 1939. Some tendency was shown for large motes not due to insect injury to be produced in increasing numbers as the season progressed. There were inconsistencies, however, the bolls from early blooms of a few of the varieties producing relatively more large motes than bolls from midseason blooms.

In considering a seasonal trend in the production of large motes the possible inclusion of those due to insect injury must be taken into consideration. At Stoneville, Miss., it was observed that in 1937 and 1939 the damage due to boll-sucking insects became very evident at about the beginning of the last third of the flowering period and increased as the season progressed. If motes formed as a result of this injury are included in a mote count, the increase in large-mote formation toward the end of the season becomes very pronounced.

Other investigators have recognized the great influence of environmental factors on mote formation or the setting of seed. Their studies have been concerned in the main with variation from year to year or throughout a given year (different pickings) for varieties grown at the same location.

Year-to-year variations were demonstrated, sometimes to a very marked degree, by Afzal (*1*), Afzal and Trought (*2*), Kearney (mean percentage of ovules fertilized per boll for Pima cotton (*8*)), Porter (*15*), and Rea (*17*).

Variations in the mote content of different pickings have also been observed. Porter (*15*) found for 2 out of 3 years an over-all tendency for mote production to increase from early to late pickings and the reverse condition in the third year. The differences between pickings were very small, however. Moreover, the varieties did not behave consistently. Afzal and Trought (*2*), working with Punjab-American cotton, found for three varieties grown in 2 years a marked and consistent tendency for mote formation to decrease from early to late pickings. A similar trend, though based on blooming period, was shown by Eaton (*5*) for Acala and Pima cottons. Afzal (*1*), working on Punjab-Desi cottons collected in five pickings, found a greater number of motes in both early and late pickings than in the midseason ones.

It must be borne in mind that the observations of Porter (*15*) were undoubtedly based on the occurrence of both large and small motes and it is very likely that those of Rea (*17*), Afzal (*1*), and Afzal and Trought (*2*) were also. Consequently the variations in mote content of bolls from different portions of the blooming period reported by these investigators are not strictly comparable with those described herein for large and small motes taken separately. Nevertheless, a comparison of the results of all investigators would warrant the conclusion that although there may be an inherent tendency for midseason blooms to produce bolls with fewer motes than those of early or late blooms, such a trend is very likely to be modified, probably by the meteorological conditions prevailing during the periods of flowering and boll development.

Variation With Position in Lock

It was thought that the importance of the effect of position in the lock upon mote formation could best be established by considering separately locks of different sizes and mote content. Previous investigators had made no such groupings.

For the sake of clarity it should be restated here that for this study the values representing the distribution of motes throughout the locks are based on the number of motes occurring at each of the different positions in relation to the total number of motes found in the lock-size sample.

Mote positions in the lock were determined for all cotton studied except the spinning test series and five of the varieties included in the special-planting samples, set I. In presenting graphically the information derived from this study it was necessary to select those varieties that were either most representative or that illustrated the variability encountered and from which samples of adequate size (at least 100 motes) had been obtained.

The data representing the relative number of motes found at the different positions throughout a lock for the different subsamples are not entirely consistent. Nevertheless, they do show certain general trends indicating that whether a given ovule will develop into a mature seed depends to a considerable degree upon the position it occupies on the placenta and the number of ovules in the carpel.

Locks with only one small mote showed on the whole a general tendency for the mote percentages for the middle positions to be smaller than those for the basal and tip positions (fig. 6). For most

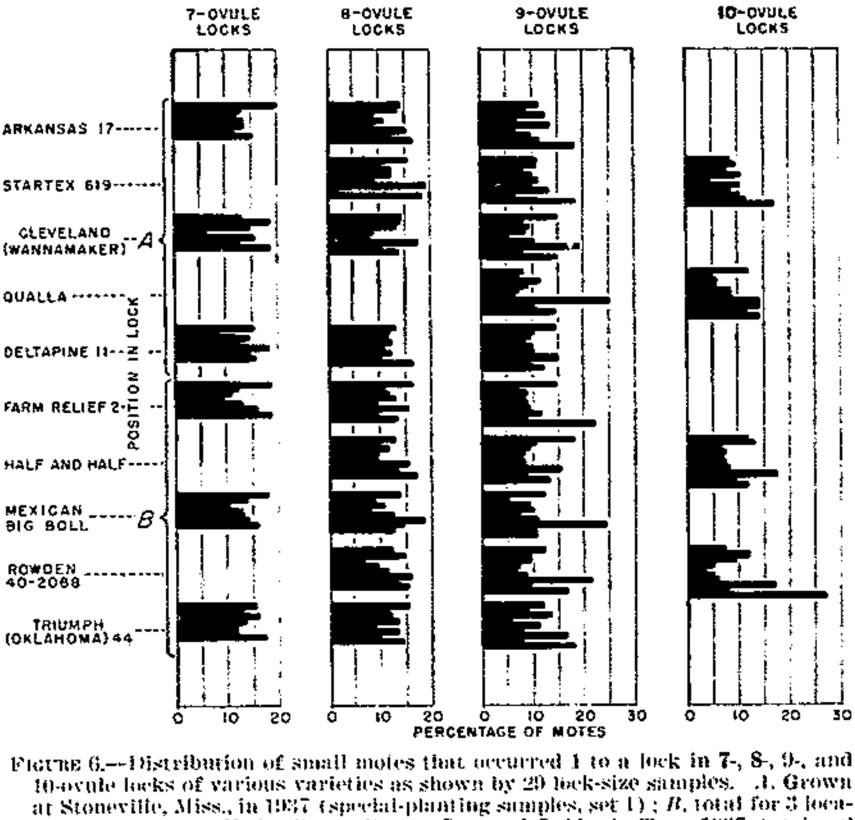

FIGURE 6.—Distribution of small motes that occurred 1 to a lock in 7-, 8-, 9-, and 10-ovule locks of various varieties as shown by 29 lock-size samples. *A*, Grown at Stoneville, Miss., in 1937 (special-planting samples, set I); *B*, total for 3 locations, Statesville, N. C., Baton Rouge, La., and Lubbock, Tex., 1937 (regional variety samples). Number of motes in each lock-size sample ranged from 103 to 915, with 62 percent of the samples containing 200 or more motes. Percentage values for the different positions are based on the number of motes occurring at each position in relation to total number of motes in the sample. Sequence of bars indicates positions from apex to base.

of the varieties studied the percentage of motes at the tip and basal positions were about the same or the basal one was somewhat the larger. A few varieties, however, notably among them being Delfos 4 and Stoneville 5, showed some tendency for the highest percentage of motes to occur at tip positions (fig. 7).

However, there are indications that the basally located ovules are under certain conditions much less apt to mature into seeds than the ovules at other positions. As the size of the lock increased, the percentage of motes at the basal positions as compared with tip positions

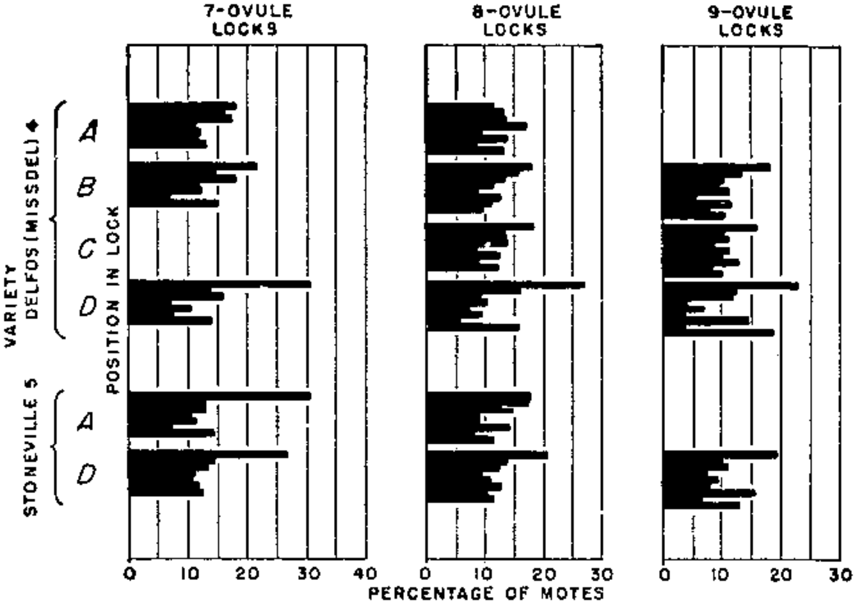

FIGURE 7.—Distribution of small motes that occurred 1 to a lock in 7-, 8-, and 9-ovule locks of Delfos 4 and Stoneville 5 as shown by 15 lock-size samples. *A–C*, Stoneville-grown samples: *A*, Special-planting samples, set I; *B*, special-planting samples, set II, 1937; *C*, special-planting samples, set II, 1939. *D*, Total for 3 locations, Statesville, N. C., Baton Rouge, La., and Lubbock, Tex., 1937 (regional variety samples). Number of motes in each lock-size sample ranged from 140 to 1,141. Percentage values for the different positions are based on the number of motes occurring at each position in relation to total number of motes in the sample. Sequence of bars indicates positions from apex to base.

also tended to increase (fig. 6). Apparently the chances that the basal ovules will mature into seeds become less as the number of ovules in the carpel becomes larger.

Furthermore, as the number of motes formed per lock increased from one to two and so forth, the additional motes tended to occupy the basal positions rather than to follow the general patterns shown when only one mote per lock was formed (fig. 8).

Some varieties showed an exceptionally high percentage of small motes at the third position from the base, that is, the fifth position in a seven-ovule lock, the sixth in an eight-ovule lock, and so forth (fig. 6). These high percentages are due in a very large measure to the occurrence of "disconnected motes." As was pointed out on page 8, although these motes have been observed to occur at all positions, they are most frequently located at the third position from the base (table 5).

Large motes not due to insect injury may occur at any position in the lock, but they tended to be concentrated at the tip and basal positions. This was true regardless of the size of the lock or the number of large motes present (fig. 9). No striking varietal differences in distribution were observed, except in one set of Mexican Big Boll

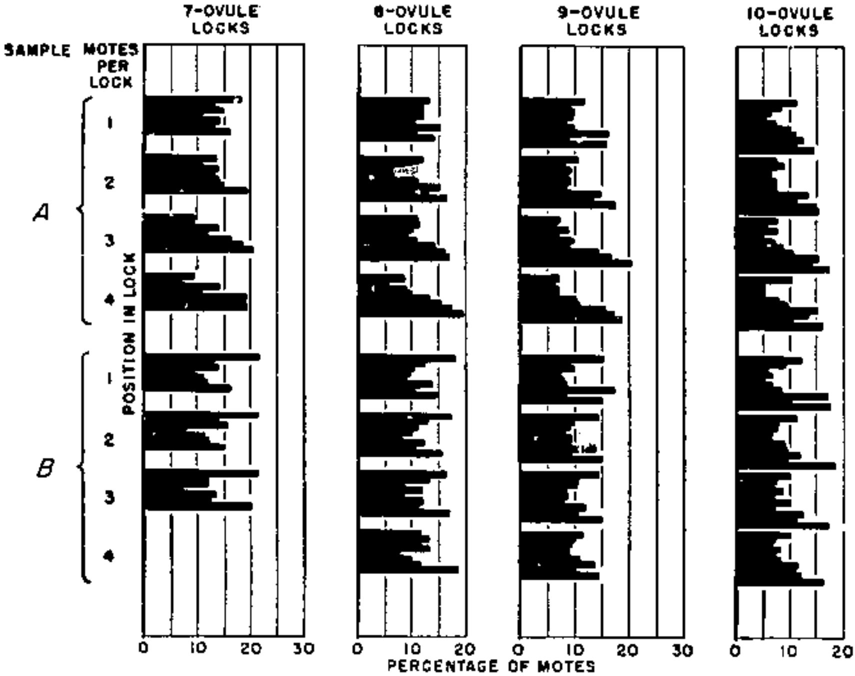

FIGURE 8.—Distribution of small motes that occurred 1, 2, 3, and 4 to a lock in 7-, 8-, 9-, and 10-ovule locks as shown by 31 lock-size, mote-number samples: *A*, Total of 12 varieties grown at Stoneville, Miss., 1937 (special-planting samples, set 1); *B*, total of 16 varieties grown at 3 locations, Statesville, N. C., Baton Rouge, La., and Lubbock, Tex., 1937 (regional variety samples). Number of motes in each lock-size sample ranged from 152 to 9,143, with 55 percent of the samples containing 1,000 or more motes. Percentage values for the different positions are based on the number of motes occurring at each position in relation to the total number of motes in the sample. Sequence of bars indicates positions from apex to base.

samples. In this lot of samples the large motes occurred in much greater numbers at tip rather than at basal positions.

The fact that motes tend to be more numerous at certain positions than at others has been observed by other investigators. Porter (*15*) and Rea (*16*) reported a tendency for the number of motes formed at the different positions in a lock to increase from tip to base. The observations of Afzal (*1*) and Afzal and Trought (*2*) are more in line with those presented in this report, namely, that there are somewhat lower percentages for the middle than for the basal positions and that in certain samples the tip ovules may form motes about as frequently as do the basal ones and in fact in some instances with greater frequency.

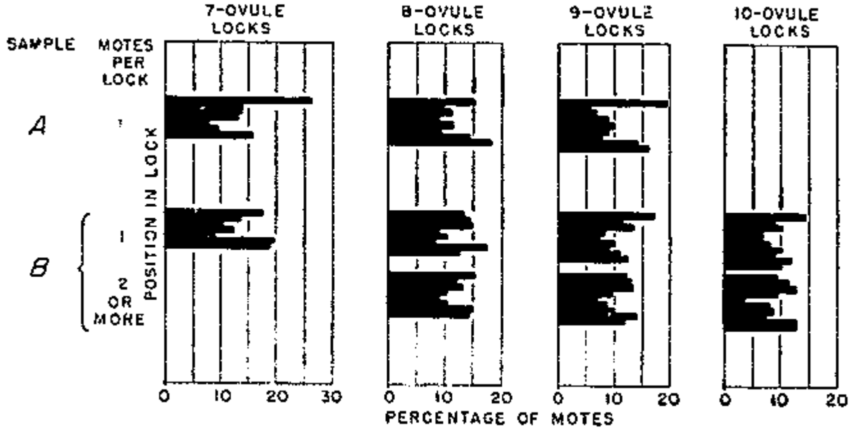

FIGURE 9.—Distribution of large motes that occurred 1 and 2 or more to a lock in 7-, 8-, 9-, and 10-ovule locks as shown by 10 lock-size, mote-number samples: *A*, Total of 12 varieties grown at Stoneville, Miss., 1937 (special-planting samples, set 1); *B*, total of 3 varieties grown at 3 locations, Statesville, N. C., Baton Rouge, La., and Lubbock, Tex., 1937 (regional variety samples). Number of motes in each sample ranged from 115 to 547. Percentage values for the different positions are based on the number of motes occurring at each position in relation to total number of motes in the sample. Sequence of bars indicates positions from apex to base.

TABLE 5.—*Distribution of disconnected motes in 7-, 8-, 9-, and 10-ovule locks in which only 1 such mote occurred for the total of 8 series for each of 16 varieties of cotton grown at 2 locations in 1937* [1]

Position in lock	Distribution of disconnected motes in locks of indicated size			
	7-ovule	8-ovule	9-ovule	10-ovule
	Percent	*Percent*	*Percent*	*Percent*
1	0	0	0	0
2	5.9	0	0	0
3	11.8	0	.4	0
4	17.6	1.4	.8	0
5	64.7	9.6	2.3	2.0
6	0	87.0	8.4	8.1
7	0	1.0	87.9	18.3
8		1.0	.2	70.6
9			0	1.0
10				0

[1] Locks examined totaled 51,200. Total number of disconnected motes for each size of lock was as follows: 7-ovule locks, 17 motes; 8-ovule locks, 207 motes; 9-ovule locks, 513 motes; and 10-ovule locks, 197 motes.

These observations of Afzal (*1*), Afzal and Trought (*2*), Porter (*15*), and Rea (*16*) are not strictly comparable with those presented herein for the procedures followed by these four investigators in obtaining and presenting their position data are very different from those employed by the author. They did not classify the locks as to size or as to the number of motes they possessed. They did not consider mote types separately and undoubtedly included in some instances the basally located false motes (*13*). Moreover, Rea grouped together each pair of seeds down the lock after considering the apical seed separately.

These differences in technique could account in some measure for the lack of agreement between the position data presented herein and that of Porter (*15*) and Rea (*16*), but the general agreement with the results of Afzal (*1*) and Afzal and Trought (*2*) is then somewhat difficult to explain. When locks with different numbers of seeds are grouped with bases coinciding as apparently done by Afzal (*1*), Afzal and Trought (*2*), and Porter (*15*) and with tips coinciding as apparently done by Rea (*16*) the mote percentages for the different positions would not be comparable with those for 7-, 8-, 9-, and 10-ovule locks taken separately. Failure to consider large and small motes separately would probably have no marked effect on the data because of the general similarity in distribution patterns. Grouping of all locks, however, regardless of the number of motes in the lock would result in basal positions having the highest mote percentages, for it has been shown that with an increase in the number of motes per lock there is an increase in the percentage of motes located at the basal positions (fig. 8). The inclusion of false motes would result in a disproportionately large mote percentage for the basal position, especially for a variety which produced false motes in considerable numbers, and undoubtedly accounts for the large number of motes which Porter (*15*) reported as occurring at this position.

Variation With Lock Size

In the study of variation with lock size only small motes were considered, since too few large motes were produced to form samples of adequate size.

Two different kinds of data were used to compare the mote-forming tendencies of locks of different sizes: (1) The percentages of motes and (2) the percentages of locks with no motes. Unfortunately the lock-size samples for each variety studied were not of equal size. Mote-percentage data based on such samples admittedly are of doubtful value. Not only are the lock-size samples of unequal size, but the differences in number of seeds per lock introduces a factor which renders the mote-percentage values obtained somewhat difficult to interpret. For example: 50 percent motes represents 4 motes in the case of an 8-ovule lock, but 5 motes in the case of a 10-ovule lock; or 1 mote in a lock equals 14.3 percent motes for a 7-ovule lock but 10 percent motes for a 10-ovule lock. Notwithstanding these difficulties presented by the lock-size samples, it was thought that the data derived from them might be of such a nature that there would be no question as to their proper interpretation.

The percentages of locks with no motes, on the other hand, are not entirely satisfactory data, since they are not based on the actual number of motes present and thus do not give complete information regarding the mote-forming tendencies of a particular sample.

The percentages of motes in 7-, 8-, 9-, and 10-ovule locks were calculated for only a portion of the special-planting samples and the 1937 regional variety samples. The percentages of 7-, 8-, 9-, and 10-ovule locks with no small motes were calculated for these same selected samples.

The mote-percentage data were very unsatisfactory. The special-planting samples showed no consistent relation between lock size and production of small motes. The regional variety samples, however, showed a rather consistent tendency for the production of small motes to increase with an increase in the number of ovules per lock (table 6). There is no obvious explanation for this discrepancy between the two sets of data. It is possible, however, that the regional variety samples, because they contained relatively few motes were capable of bringing out a trend which the special-planting samples, because they contained more motes, could not demonstrate.

Data representing the percentages of locks with no small motes were very consistent, showing, with but few exceptions, a decrease in the percentages of locks with no small motes as the size of the lock increased (table 7).

In spite of the lack of consistency and even questionable value of the mote-percentage data, the very great consistency of the data representing the percentage of locks with no motes would justify the conclusion that as the number of the ovules in a carpel increases, the greater is the possibility that one or more of them will fail to ripen into mature seeds.

TABLE 6.—*Small motes produced in the 7-, 8-, 9-, and 10-ovule locks of 4 varieties grown at 2 locations in 1937* [1]

Location and variety	Motes present in locks of indicated size			
	7-ovule	8-ovule	9-ovule	10-ovule
Statesville, N. C.:	*Percent*	*Percent*	*Percent*	*Percent*
Acala (Rogers)	7.1	8.0	8.8	--------
Deltapine 11	3.9	3.5	4.5	--------
Half and Half	-------	6.7	7.1	8.8
Mexican Big Boll	4.9	4.0	4.8	--------
Lubbock, Tex.:				
Acala (Rogers)	7.1	8.8	10.8	--------
Deltapine 11	3.9	4.5	7.0	--------
Half and Half	6.5	6.5	7.5	10.2
Mexican Big Boll	4.8	5.4	6.2	--------

[1] Each value is based on a lock-size sample with at least 1,000 seeds except that for the 10-ovule locks of Half and Half at Statesville, N. C., which contained only 860 seeds. Total number of locks examined for each variety at each location, 1,600 (100 locks for 4- and 5-lock bolls of 8 replications); lock-size samples ranged from 149 to 956 locks each.

TABLE 7.—*7-, 8-, 9-, and 10-ovule locks with no small motes, produced by varieties of cotton grown at 3 locations in 1937*[1]

Location and variety	Locks of indicated size with no small motes			
	7-ovule	8-ovule	9-ovule	10-ovule
Stoneville, Miss.:[2]	*Percent*	*Percent*	*Percent*	*Percent*
Acala (Rogers)	46.1	42.7	38.9	
Acala (Slick-Seeded)	40.5	33.1	28.4	
Arkansas 17	53.4	50.6	44.7	
Cleveland (Wannamaker)	50.8	49.4	46.6	
Cook 912	60.3	52.8	50.4	47.4
Delfos (Missdel) 4	49.6	45.8	50.8	
Deltapine 11	66.5	64.6	62.3	
Dixie Triumph 759	66.1	63.8	60.7	
Farm Relief 2	51.0	47.9	45.8	
Half and Half	41.8	40.8	38.2	33.0
Mexican Big Boll	72.8	57.8	61.0	
Qualla		48.5	48.5	41.7
Rowden 40-2088	64.0	57.6	57.8	
Startex 619		50.5	52.8	46.6
Stoneville 5	58.5	55.2	51.7	
Triumph (Oklahoma) 44	60.1	58.4	56.1	
Wilds 5	43.1	43.2	42.6	
Statesville, N. C.:[3]				
Acala (Rogers)	61.6	51.3	44.1	
Deltapine 11	77.6	75.6	65.5	
Half and Half		60.4	52.0	40.1
Mexican Big Boll	70.5	72.0	65.4	
Lubbock, Tex.:[3]				
Acala (Rogers)	60.2	48.8	30.8	
Deltapine 11	76.8	70.7	54.1	
Half and Half	64.4	59.2	53.7	41.7
Mexican Big Boll	71.2	65.2	55.6	

[1] Each value is based on samples of at least 100 locks. Total number of locks examined for each variety ranged from 1,441 to 2,728.
[2] Special-planting samples, set I.
[3] Regional variety samples.

VARIATION WITH NUMBER OF LOCKS PER BOLL

The mote-forming tendencies of four- and five-lock bolls were compared by using both the percentages of motes formed and the percentages of locks with no motes. This information was obtained for the special-planting samples, set I, and for the 1937 regional variety samples. The four- and five-lock boll samples for any one of the varieties included in the special-planting samples, set I, were not of uniform size. It is realized that percentage data based on such samples are not strictly comparable. The percentage values will be influenced to some degree by the number of items involved. For example: two locks without motes comprise 50 percent of a four-lock boll, but only 40 percent of a five-lock one; and, assuming eight seeds to a lock, four motes in a boll give a mote percentage of 12.5 for a four-lock boll, but only 10.0 percent for a five-lock one. Nevertheless, the data derived from these samples are presented in this discussion since they show the same general differences as the samples of uniform size representing the 1937 regional variety investigations.

Both sets of samples showed a fairly consistent tendency for five-lock bolls to have relatively more small motes and relatively fewer locks with no motes than four-lock bolls, except for the varieties grown at Lubbock, Tex. (tables 8 and 9). In fact, the three locations selected from the 1937 regional variety investigations showed a progressive decrease in the difference between four- and five-lock bolls, in both the percentage of motes and of locks with no small motes (tables 8 and 9), Statesville, N. C., showing the greatest difference and Lubbock, Tex., little or no difference for the varieties taken as a whole. No attempt is made herein to explain this inconsistent behavior other than to suggest that though there may be, under certain conditions, an inherent tendency for mote formation to take place with greater frequency in five- than in four-lock bolls, the extent to which the difference actually occurs may be related to the number of five-lock bolls produced. Approximately 15.6 percent[11] of the total number of

TABLE 8.—*Small motes produced in 4- and 5-lock bolls of 16 varieties of cotton grown at 4 locations in 1937*

Variety	Motes at indicated location							
	Statesville, N. C.[1]		Baton Rouge, La.[1]		Lubbock, Tex.[1]		Stoneville, Miss.[2]	
	4-lock	5-lock	4-lock	5-lock	4-lock	5-lock	4-lock	5-lock
	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Acala (Rogers)	7.8	10.2	6.6	8.0	9.1	10.4	9.7	13.1
Arkansas 17	3.7	5.0	4.7	5.2	5.0	6.1	13.2	13.5
Cleveland (Wannamaker)	7.6	7.7	6.5	7.0	8.0	7.3	11.6	12.3
Cook 912	4.4	4.5	4.4	4.9	5.9	5.6	10.0	12.1
Delfos (Missdel) 4	5.0	7.7	4.8	5.3	6.1	7.7	10.3	14.6
Deltapine 11	3.2	5.2	3.3	4.2	5.0	5.3	7.4	10.5
Dixie Triumph 759	3.8	4.4	4.5	4.7	6.6	4.5	6.8	8.8
Farm Relief 2	6.4	8.1	5.8	6.5	9.8	9.7	11.1	12.8
Half and Half	7.2	8.8	7.8	8.1	9.3	8.4	17.0	17.0
Mexican Big Boll	4.4	4.7	4.0	4.5	6.0	5.6	7.9	8.0
Qualla	7.0	8.8	6.1	6.7	9.9	9.8	11.6	11.2
Rowden 40–2088	4.8	6.0	4.2	4.5	5.5	6.4	8.6	10.0
Startex 619	5.4	5.9	5.8	6.0	7.6	7.4	10.0	10.5
Stoneville 5	7.3	8.8	5.6	5.8	7.6	7.8	8.3	10.9
Triumph (Oklahoma) 44	3.8	4.3	3.3	4.3	5.7	5.3	11.3	13.6
Wilds 5	6.4	9.3	5.7	8.0	13.1	13.4	12.0	11.9
Mean	5.5	6.8	5.2	5.9	7.5	7.5	10.4	11.9

[1] Regional variety samples; each value is the mean of 8 observations; each observation is based on a sample of 100 locks (1 replication), totaling approximately 800–900 seeds.

[2] Special-planting samples, set 1; each value is based on a sample composed of at least 250 locks, totaling approximately 2,000 seeds; majority of samples composed of 500–1,000 locks each.

[11] Unpublished information, regional variety investigations, 1935–37.

bolls produced at Lubbock had five locks as compared with 50.6 percent at Baton Rouge, La., and 37.6 percent at Statesville, N. C. In the Stoneville sample 62.5 percent of the bolls had five locks. It would be expected that the physiological conditions of plants producing five-lock bolls predominately would be such as to enable them to nourish the extra number of seeds in five-lock as compared with four-lock bolls. This capacity could conceivably result in there being no difference in the relative number of motes formed in the two types of bolls.

TABLE 9.—*Locks with no small motes in 4- and 5-lock bolls of 16 varieties of cotton grown at 4 locations in 1937*

Variety	Locks with no small motes at indicated location							
	Statesville, N. C.[1]		Baton Rouge, La.[1]		Lubbock, Tex.[1]		Stoneville, Miss.[2]	
	4-lock	5-lock	4-lock	5-lock	4-lock	5-lock	4-lock	5-lock
	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Acala (Rogers)	52.9	44.4	65.1	57.1	52.0	46.2	50.2	40.8
Arkansas 17	74.0	71.6	68.8	69.0	69.4	67.8	49.2	51.9
Cleveland (Wannamaker)	52.1	54.5	62.2	61.6	58.5	61.6	54.2	48.2
Cook 912	68.5	70.8	71.1	68.1	67.0	64.5	52.7	52.2
Delfos (Missdel) 4	68.4	55.0	71.0	67.4	66.0	59.5	52.8	41.2
Deltapine 11	78.1	66.2	77.8	73.2	71.6	69.6	67.4	61.2
Dixie Triumph 759	75.0	73.0	72.1	70.4	68.1	72.5	66.0	63.4
Farm Relief 2	59.5	56.1	67.0	61.6	49.6	52.2	51.7	45.6
Half and Half	53.2	52.0	50.6	53.4	55.0	55.4	39.2	35.7
Mexican Big Boll	69.5	69.2	75.2	73.5	63.8	66.0	59.1	61.4
Qualla	55.8	47.0	58.0	57.9	46.9	46.9	45.5	46.5
Rowden 40-2088	67.9	63.6	74.1	73.4	66.8	62.0	61.9	56.2
Startex 619	63.1	62.9	64.2	63.4	61.1	57.6	54.0	50.2
Stoneville 5	56.5	51.1	66.9	63.9	56.1	56.5	61.1	53.2
Triumph (Oklahoma) 44	75.0	71.6	77.9	72.9	69.4	69.8	57.9	58.4
Wilds 5	57.2	48.5	62.2	57.6	37.6	37.2	44.6	42.8
Mean	64.2	59.8	67.8	65.3	59.9	59.1	54.2	50.6

[1] Regional variety samples; each value is based on an 800-lock sample (100 locks for each of 8 replications).
[2] Special-planting samples, set 1; each value is based on a sample composed of at least 250 locks; majority of samples composed of 500–1,000 locks each.

It was not demonstrated that the number of locks in a boll had any pronounced influence upon the number of large motes that were produced. Relatively few motes of this type occurred in the different samples studied and undoubtedly larger samples would be required to establish definitely whether such relations existed.

It has been observed by others that the number of locks in a boll probably has some influence upon the number of motes produced. Afzal (*1*) and Afzal and Trought (*2*) found four-lock bolls to have in general fewer perfect locks than three-lock bolls, and Rea (*16*) observed that the seed cotton of five-lock bolls contained more motes than four-lock bolls. The differences they found between the boll types, however, are much greater than those reported in this publication. One explanation for the discrepancy may be, as in other cases, that Afzal and others included false motes in their mote data. Such bodies have been observed to occur more frequently in five-lock than in four-lock bolls (*13*) and would presumably then occur more frequently in four-lock than in three-lock.

Although the data representing the relative abundance of motes and percentages of perfect locks for 7-, 8-, 9- and 10-ovule locks and 4- and 5-lock bolls are not entirely satisfactory, as pointed out previously, nevertheless they do warrant the conclusion that with an increase in the number of potential seeds in a lock or in a boll, there is, at least under certain conditions, possibility that one or more of them will fail to reach maturity.

DISCUSSION

The extents to which mote formation has been shown to vary with variety, environment, position in the lock, number of potential seeds per lock, and number of locks per boll and the extent to which the formation of large and small motes may differ particularly with regard to varietal and environmental factors indicate that the mote-formation problem is not simple. The factors directly responsible are undoubtedly many, and there are various suggestions in the rather limited amount of literature on motes as to what the factors may be.

It was suggested by Afzal and Trought (*2*) that mote formation may be due to defective pollination. It can readily be demonstrated that ordinarily there is sufficient pollen deposited on a stigma to supply all the ovules in an ovary with a pollen tube. However, conditions which prevent or inhibit pollination or fertilization may develop. It is possible, however, that these conditions may account for only a small percentage of the motes present in a cotton crop, since the majority of the defectively pollinated bolls would be shed. Afzal and Trought, as a result of studies in which pollination was restricted, were of this opinion. Their contention is supported by the fact that all motes that they examined microscopically showed some tissue development indicating that, for the majority of motes in seed cotton, abortion took place after fertilization.

That failure to receive a pollen tube should not be completely disregarded as a factor in mote formation was shown by some exploratory morphological studies that were undertaken in connection with the macroscopic observations reported in this publication. It was found that many of the motes sectioned had received no pollen tube. Moreover, ovaries gathered on the day following anthesis and dissected and stained to demonstrate the pollen tubes showed an occasional ovule with no pollen tube entering it.

Furthermore, it is possible that the pattern of small-mote distribution within the lock may be explained in part by the failure of certain ovules to receive pollen tubes (*16*). The tendency for small motes to be concentrated at basal rather than middle positions when they occur two or more in a lock and the tendency for the concentration to increase with an increase in the number of ovules per carpel might indicate that the basally located ovules are unfavorably situated for pollen-tube reception. It is logical to assume that the first pollen tube to enter an ovary would enter the apical ovule, the next pollen tube the next ovule down, and so forth; this assumption has been borne out by a series of unpublished observations made on the evening of the day of flowering. If for some reason there were not sufficient pollen grains to supply tubes for all ovules or if conditions unfavorable for pollen-tube growth suddenly developed, the basal ovules would then be the ones most likely to receive no pollen tubes. In that case the percentage of motes at the different positions due to this cause would be likely to increase from tip to base of the lock. That there are other factors operating is shown by the fact that in locks with only one mote each a considerable percentage of the motes occupy the middle and tip positions (fig. 6).

Although the distribution of large motes within the lock is similar to that of small motes, the explanation for the distribution pattern would undoubtedly not be the same since the factors responsible for large-mote formation appear to be different from those responsible for the formation of small motes.

Exploratory morphological studies have shown [12] that the reception of a pollen tube does not necessarily insure that an ovule will develop into a mature seed. This confirmed the observations of Afzal and Trought (*2*). The factors responsible for the failure of such ovules to mature are undoubtedly many. It has been suggested that the failure is largely due to the influence of nutritional factors (*2, 16, 17*). This view receives some support from the tendency within varieties for the five-lock bolls to have relatively more motes than four-lock bolls and by the less well defined tendency for the relative number of motes found to increase as the number of potential seeds per lock increases. No consistent tendencies have been demonstrated, however, for varieties with an above-average lock size or for those producing predominantly five-lock bolls to have relatively more motes than varieties with small locks or those producing mainly four-lock bolls (table 10). In fact, the available data would indicate that, if varieties tend to produce large locks or five-lock bolls, they would appear to be able to supply sufficient nourishment to take care of the extra seeds.

The importance of adequate food and water supply in the proper nourishment of seeds was suggested by Afzal and Trought (*2*) in accounting for the fewer motes found in widely spaced plants as compared with those spaced normally and in plants supplied with additional water and fertilizer as compared with those receiving less. Rea (*17*) attributed to difference in water supply the fewer motes found in the seed cotton from 17 varieties grown in a wet as compared with a dry year, and Bailey (*3*) pointed out the importance of an adequate water supply for a high rate of seed setting.

Afzal and Trought (*2*) were of the opinion that nutritional factors might account for the tendency for bolls from early and late blooms to have more motes than those from midseason blooms, the plants being at their best at midseason and therefore better able to nourish their seeds than in the early or late part of the growing season. The differences in mote content of bolls from different portions of the blooming period reported in this publication and by other investigators have not been entirely consistent, however. Although there probably

[12] Unpublished observations.

is a seasonal trend in mote formation in relation to the ability of plants to nourish their seeds, these inconsistencies, as has been pointed out previously, seem to indicate that this relation can be modified at any time during the periods of flowering and of boll development, probably by meteorological conditions.

Afzal and Trought (2) made experiments to determine the influence of date of sowing on mote formation and found that the later the sowing was done the smaller was the mote percentage. This suggested that the plants from the later sowings were better able to nourish their seeds.

The results of Eaton (5) are of interest. Experimenting with Acala and Pima cottons, he found that, when only one boll was allowed to a fruiting branch, the plants so treated produced fewer imperfect seeds (large motes?) than the controls. The two cottons did not behave

TABLE 10.—*Small motes, ovules per lock, and 5-lock bolls produced by varieties of cotton grown at Stoneville, Miss. (special-planting samples), 1937 and 1939*

Year, set, and variety	Small motes	Ovules per lock	5-lock bolls
1937			
Set I:[1]	*Percent*	*Number*	*Percent*
Acala (Rogers)	12.5	8.03	73
Acala (Slick-Seeded)	20.1	7.57	34
Arkansas 17	13.3	7.87	42
Cleveland (Wannamaker)	11.7	7.95	70
Cook 912	11.5	8.38	63
Delfos (Missdel) 4	12.2	7.83	39
Deltapine 11	8.6	7.89	39
Dixie Triumph 759	8.5	7.73	83
Farm Relief 2	12.0	8.06	57
Half and Half	17.2	8.52	62
Mexican Big Boll	7.7	8.08	73
Qualla	11.2	9.21	78
Rowden 40-2088	9.4	8.44	58
Startex 619	10.1	8.88	77
Stoneville 5	9.6	7.96	63
Triumph (Oklahoma) 11	11.6	8.15	67
Wilds 5	12.2	8.30	56
Set II:[2]			
Delfos (Missdel) 4	13.7	8.10	45
Deltapine 11	9.0	8.21	48
Half and Half	23.1	8.92	79
Mexican Big Boll	11.1	8.28	66
Qualla	15.2	9.44	84
Stoneville 5	12.6	8.33	64
1939			
Acala (Slick-Seeded)	15.6	8.41	44
Cleveland (Wannamaker)	9.7	8.87	71
Delfos (Missdel) 4	9.2	8.59	45
Half and Half	18.6	9.11	71
Mexican Big Boll	8.8	8.75	76

[1] Values based on seed cotton supplied by not less than 413 bolls of each variety; maximum number, 678 bolls.

[2] Values based on seed cotton supplied by not less than 699 bolls of each variety; maximum number, 1,892 bolls.

consistently, however, in the production of what he classed as "motes" (small motes only?). In the case of Acala the one-boll-per-branch plants produced slightly but consistently more motes than the controls, but the reverse was true in the case of Pima. Nutritional factors could explain the difference between the one-boll-per-branch plants and the controls in the production of imperfect seeds (large motes), but they are not the complete explanation for the differences in the production of what would probably be considered in the experiments reported in this bulletin as "small motes," at least in the case of Acala.

The importance of insect injury in promoting mote formation must not be overlooked. Much of this injury is caused by the direct feeding of boll-sucking insects on the young bolls and the subsequent aborting of the injured seeds. There is the possibility also that mote formation may result indirectly from injury by insects to cotton in the bud stage. Injury to a portion of the style and stigma and the consequent failure of the ovules in the corresponding carpels to develop might account for some of the lopsided but seemingly disease-free bolls that are occasionally encountered. Moreover, insect injuries may provide a medium for disease micro-organisms to enter the plant.

The fairly consistent varietal differences in the formation of both small and large motes points to the operation of specific heritable factors. There is practically no direct evidence at present, however, as to what these specific factors may be.

It has been suggested that inherited lethals may be a factor in mote formation (*6*). Afzal and Trought (*2*) and Rea (*16*) pointed out, however, that the distribution of motes throughout the lock according to a rather definite pattern precludes the operation of lethal factors. Since the information presented in this bulletin justifies the conclusion that many factors are involved in seed abortion, it would not seem at all improbable that the pattern of mote distribution within the lock, particularly that for small motes, may be a composite one consisting of one or more superimposed patterns or of one or more patterns superimposed on a random distribution.

Kerr [13] pointed out that allosyndesis (*4*) is another genetic factor which might be very important in mote formation. Since upland cottons are considered to be amphidiploids or allotetraploids (*18*) (their haploid complement consists of two dissimilar sets of chromosomes), there is always a chance that at the time of reduction division a chromosome or chromosomes from one set might pair with those of the other (allosyndesis). It is possible that such behavior might give a chromosome distribution that would result in nonfunctional gametes. That some such condition or behavior may occur or at least that incompatibilities of some nature do exist is borne out by observations on sectioned motes from young bolls that had developed as a result of open pollination.[14] In some instances a pollen tube had erupted its contents into the embryo sac, but no embryo had developed. In some such cases a fragmentary or abnormal-appearing endosperm may have been formed.

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[13] Thomas Kerr, principal fiber technologist, Division of Cotton and Other Fiber Crops and Diseases, in correspondence concerning the problems of mote formation.

[14] Unpublished observations.

It should be stated in regard to this possible mote-forming factor that no comparison has been made between the motes of cottons with the diploid number of chromosomes and the American allotetraploids.

The complete explanation as to how varietal and environmental factors are responsible for conditions resulting in mote formation and as to whether they interfere with pollination and fertilization, limit food and water supply, or exert other inhibitory influences awaits further more extensive investigations. It is hoped that the information presented in this bulletin may help point the direction such investigations should take.

SUMMARY

The aborted seeds, or motes, in seed cotton are an important problem because they represent waste, both in yield and in manufacturing, and are a source of small imperfections in yarn and cloth.

In the classification presented the seeds which fail to reach maturity are divided into two groups: (1) Those whose formation is very obviously due to the action of insects and micro-organisms and (2) those whose formation is probably due to the effect of genetic and environmental factors. It is the latter group with which this bulletin is primarily concerned. This group is subdivided into two classes, small motes and large motes, the division being based on size and general appearance and incidentally upon the nature of the small imperfections to which each class gives rise. Bases for distinguishing the two classes from each other and the large motes from mature seeds are given.

Motes were counted in many samples to establish the extent to which mote formation might be related to variety, environment (location and year of growth and date of bloom), position in the lock, number of potential seeds per lock, and number of locks per boll.

There were found to be significant differences in the relative numbers of both small and large motes in samples representing different varieties and environments. In general, the influence of environment as represented by place and year of growth was shown to be a much more important factor in mote formation than the influence of variety, though for the most part varieties tended to retain about the same rank no matter where or when grown. Seasonal factors as represented by differences from year to year were more important than locational ones in their influence upon the number of large motes produced; the reverse was true for small motes.

There was considerable variation in the number of small motes that were formed in bolls representing the daily sequence of blooms. The high mote percentage for certain days could be related to rainfall during the time when pollination would ordinarily have taken place, the rain presumably interfering with pollen deposition, pollen-tube development, or both. High mote percentages for other days could be related to high maximum temperatures. Moreover, there was a marked tendency for increases and decreases from day to day in maximum daily temperature to be followed by corresponding increases and decreases in the production of small motes. The production of large motes, however, could not be related to the amount and time of rainfall or the maximum temperature on the day of flowering.

It is probable that the high percentage of small motes in bolls from flowers that bloomed on rainy days would have little importance from the standpoint of the crop as a whole, for comparatively few such bolls would be set. High temperatures, however, were not found to be associated with extensive shedding, and so it is probable that the mote content of a crop is determined to a very large extent by temperature variations during the blooming period.

No consistent trend in the production of small motes was observed for bolls from the early, middle, or late portion of the flowering periods. Some tendency was observed for large-mote formation to increase as the season progressed, especially if the large motes due to insect injury are included.

In general, in locks which possessed only one small mote, relatively fewer motes were found at middle than at tip and basal positions. Usually the percentages of motes at the tip and basal positions were about the same or there was a slightly higher percentage located at the base. A few varieties, however, showed a fairly consistent tendency for the percentages of motes at the tip positions to be greater than at the base. With an increase in the number of seeds per lock or in the number of small motes the percentages located at the base of the lock tended to become larger than at the tip, indicating that the basal positions taken as a whole are the most unfavorable for seed development. Large motes tended to be concentrated at tip and basal positions regardless of the number present or the number of seeds per lock.

There is a slight tendency within a variety for the relative number of small motes produced to increase with an increase in the number of ovules per lock or locks per boll.

These observations indicate that there are at least several, perhaps many, factors responsible for mote formation and that those responsible for the formation of small motes are different from those responsible for the formation of large ones. Some factors are certainly genetic in nature, but others are environmental. Though precise information regarding the exact nature of these factors is lacking, a discussion is presented concerning some of the factors that have been suggested as being more or less directly responsible. The complete explanation will be found only through more extensive investigations.

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U. S. GOVERNMENT PRINTING OFFICE 1949

For sale by the Superintendent of Documents, U. S. Government Printing Office
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