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SEEDCOAT FRAGMENTS IN COTTON AN ELEMENT OF YARN QUALITY
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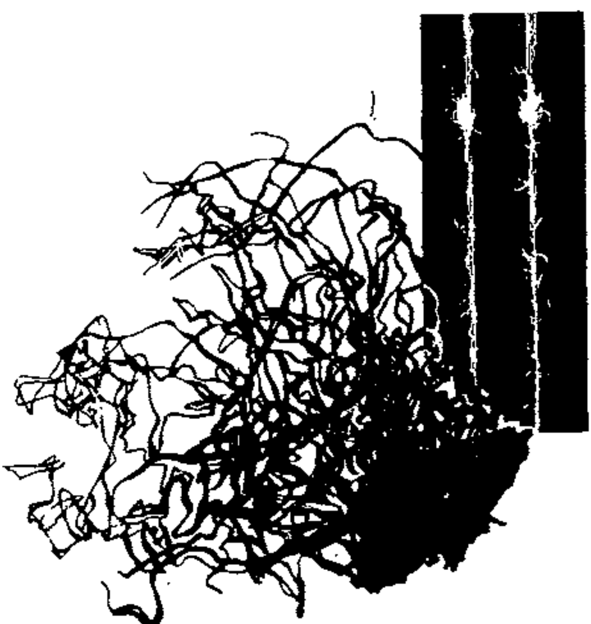
# SEEDCOAT FRAGMENTS IN COTTON . . .

## an element of yarn quality

by Norma L. Pearson





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## Contents

# SEEDCOAT FRAGMENTS IN COTTON—an element of yarn quality[1,2]

By NORMA L. PEARSON, *cotton technologist, Field Crops Research Branch, Agricultural Research Service*.[3]

## Introduction

Appearance is one of the chief factors determining the quality of cotton yarn. Grade standards have been developed for evaluating yarn appearance. The appearance grade of a yarn is based on its "relative evenness, smoothness, and freedom from foreign matter" (*3*).[4] The relative smoothness and freedom from foreign matter is determined largely by the number of small imperfections that are present.

Neps and seedcoat fragments form most of the imperfections. As they occur in yarn they are similar in size and often in general appearance and frequently, therefore, are not distinguished from each other but are grouped together and all are counted as neps. However, they are two distinctly different structures (*7*). Neps are knots of tangled fibers (fig. 1, *C* and *B*). Seedcoat fragments are bits of tissue from either motes (*12*) or seeds with tufts or fibers attached (fig. 1, *A* and *D*).

Because seedcoat fragments are made up of both fibers and bits of seedcoat tissue, they affect the appearance of the yarn in several ways. The fiber tufts present dyeing difficulties similar to those given by neps and may appear in dyed yarn or cloth as undesirable specks that are either lighter or occasionally darker than their background (*7*). In addition, the particles of seedcoat stand out against a light background as unsightly dark specks (fig. 1, *E*). With certain treatments the seedcoat tissue may be rendered inconspicuous or may even be dissolved (*5*). In either case, the neplike tufts would still remain and they might appear in the fabric as conspicuous imperfections. If a seedcoat fragment is closely incorporated in the yarn, the dissolution of the seedcoat tissue might lead to a hole or at least to a weakened place in the yarn or fabric.

Seedcoat fragments affect not only the quality of the finished product but are also a factor in processing. Along with neps, they are

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[1] Submitted for publication December 15, 1954.

[2] This study is part of the regional cotton variety investigations conducted jointly by the Field Crops Research Branch, Agricultural Research Service, and the Cotton Division, Agricultural Marketing Service, United States Department of Agriculture. (The cooperating agencies were formerly known as the Bureau of Plant Industry, Soils, and Agricultural Engineering, Agricultural Research Administration and the Cotton Branch, Production and Marketing Administration.)

[3] Appreciation is expressed to H. D. Barker, agricultural administrator, and Thomas Kerr, principal fiber technologist, Field Crops Research Branch, for helpful suggestions and criticisms. Acknowledgement 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 Earl E. Berkley, Anderson, Clayton and Company, for the photograph of cloth with seedcoat fragments.

[4] Italic numbers in parentheses refer to Literature Cited p. 16.

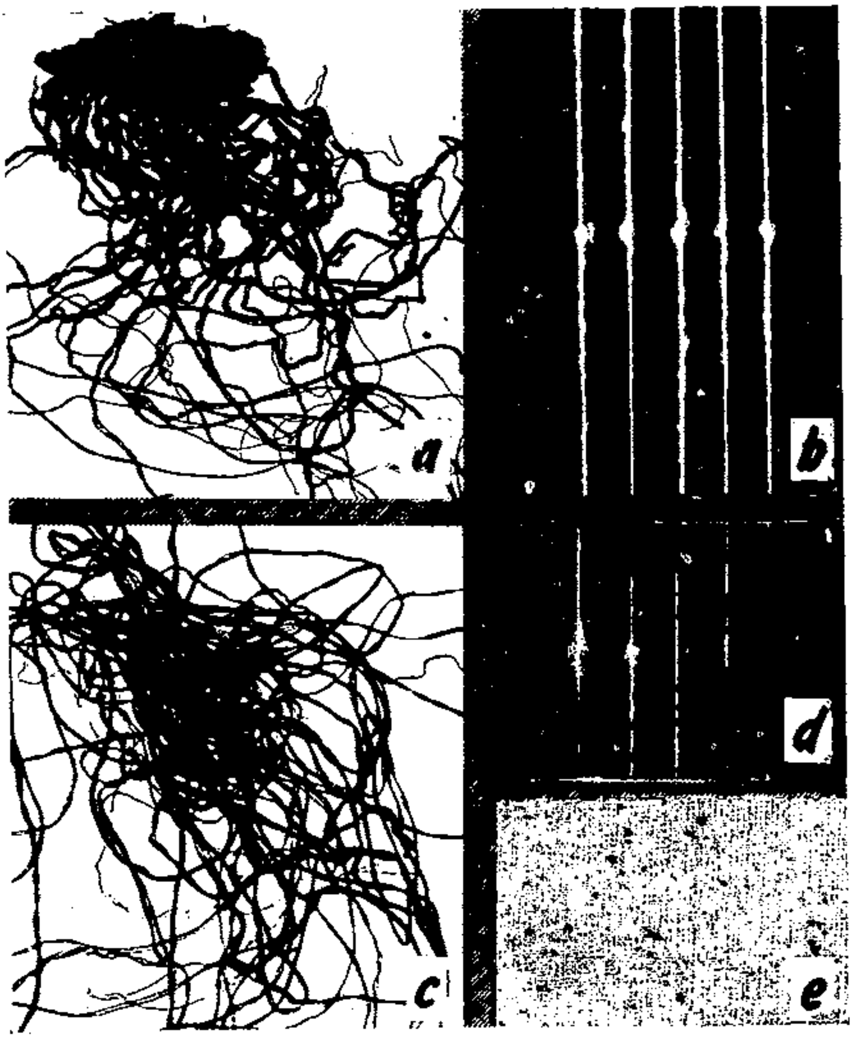


FIGURE 1.—*A*, a seedcoat fragment, × 50; *B*, neps in yarn, × 2½; *C*, a nep × 41; *D*, seedcoat fragments in yarn, × 2½; *E*, cloth with an extremely large number of seedcoat fragments, × 1.

probably responsible for some of the "ends down" in spinning. They are also a problem of waste, for in the raw stock they represent material that was purchased at the price of good fiber. Moreover, efforts to remove them in opening, cleaning, carding, or combing probably entail the loss of considerable good fiber along with them, for they cling to the lint tenaciously (*5*).

Many investigations have been made concerning the factors affecting nep formation, with the result that considerable information has been accumulated as to how and why neps are formed (*2*). On the other hand seedcoat fragments have received little attention. This lack of attention may be due in part, at least, to the failure of those concerned with cotton quality to consider seedcoat fragments as distinct from neps and to the fact that, as a general rule, these fragments do not occur in yarn so abundantly as do neps.

A complete understanding of the factors contributing to yarn quality as well as to spinning performance should include, however, a knowledge of the factors affecting the occurrence and abundance of seedcoat fragments in ginned lint, in the products of the various stages in yarn manufacturing, and particularly in the yarn itself.

This bulletin presents a classification and description of seedcoat fragments of cotton, together with the results of a study of the variations in their content in selected yarns and the extent to which these variations were related to those in the structures giving rise to the fragments.

## Classification, Origin, and Description of Seedcoat Fragments

Seedcoat fragments may be classified as follows:

- Seed fragments
  - From the chalazal end
  - From other than the chalazal end
  - Funiculus or stalk at the micropylar or pointed end (this is not strictly seedcoat tissue)
- Large-mote fragments
- Small-mote fragments
- False motes (and their fragments?)

Chalazal fragments are produced as a result of chalazal chipping (*9*, *13*). The seedcoat tissue at the chalazal, or rounded, end of the cotton seed is not so compact as that covering the rest of the seed (*9*), and may be broken when a pull is exerted upon the tuft of fibers originating from this area. Such breakage may occur in ginning, with the result that some seeds chip; that is, a portion of the chalazal seedcoat tissue with attached fibers is pulled from the seed. These rather large fragments pass into the lint. There they appear as compact, naplike masses (*8*), since the fiber tuft is much more conspicuous than the seedcoat tissue (fig. 2, *A*). During the opening, cleaning, and carding processes these large fragments will be broken up into smaller ones, some of which may persist into the yarn.

Small fragments of chalazal origin may be identified by the presence of the dark, irregularly shaped cells that characterize the spongy tissue underlying the chalazal epidermis (*9*), and by the lack of compactness of the epidermis itself (fig. 2, *B* and *C*). The characteristics of the fiber tuft are usually of secondary importance in identification, though they may be helpful in some cases. The lint fibers at the chalazal end of the mature seed are thin-walled (*6*), but the fuzz fibers ordinarily do not appear to differ appreciably in wall thickness from those at other positions on the seed. Fuzz fibers alone, then, would not be helpful in doubtful cases, but the presence of bases of thin-walled lint fibers might be of some value if the seedcoat tissue could not be positively identified as chalazal tissue.

Most of the fragments from mature seeds found in yarn (or in samples of sliver and roving) are of chalazal origin. However, occasionally they may be from some other portion of the seed, apparently cut from the seedcoat by the teeth of the ginsaw (*7*). The fragments

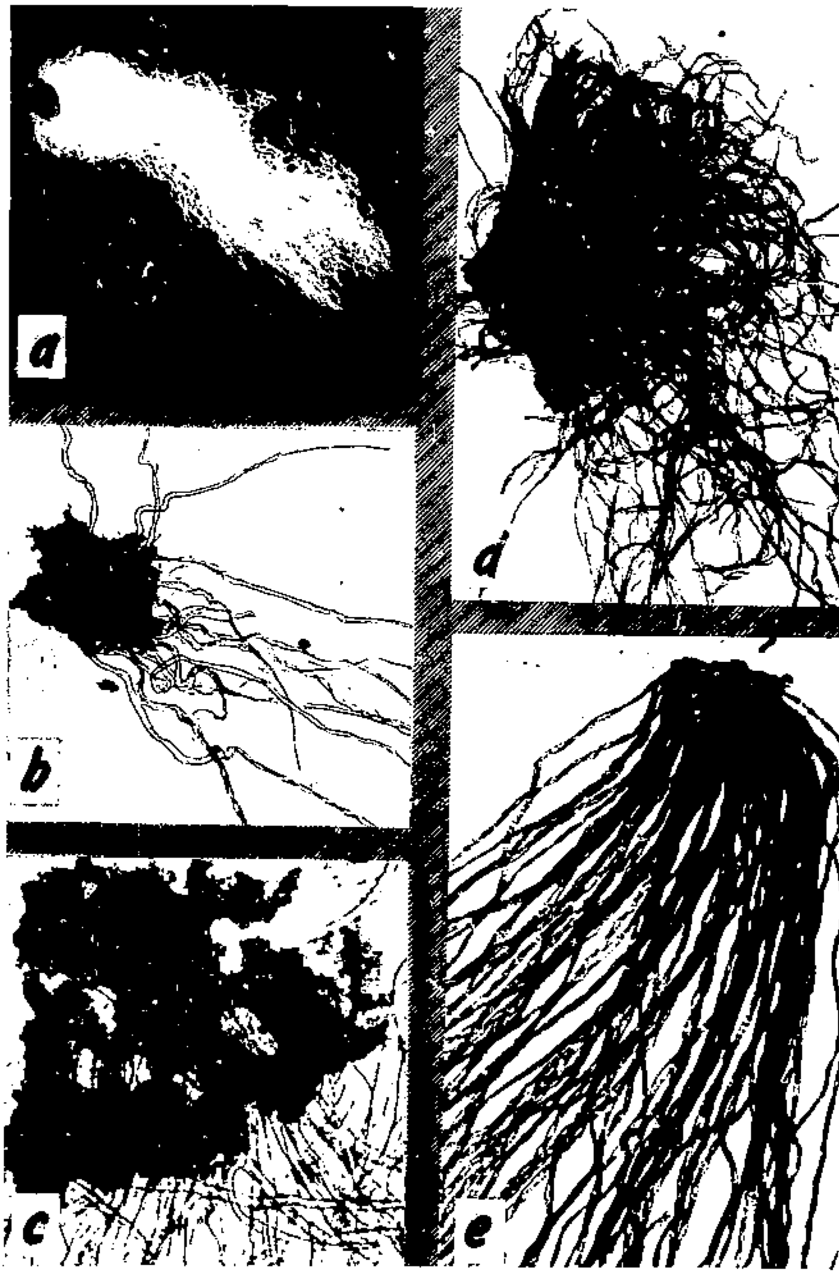


FIGURE 2.—*A*, A large chalazal fragment, × 3; *B*, a small chalazal fragment (note ragged edge of particle of seedcoat tissue), × 50; *C*, seedcoat portion of a chalazal fragment showing fragile nature of chalazal tissue, × 100; *D*, fragment from large mote, × 41; *E*, fragment from small mote, × 60.

observed in ginned lint that were apparently formed in this way were usually rather large, but some of them may be broken up further in carding, or lost. Fragments from portions other than the chalazal end of the seed may be recognized by the compact nature of the dark seedcoat tissue, and by the presence of fibers characteristic of mature seeds.

The small stalk at the pointed or micropylar end of each seed is frequently broken off during ginning. The stalks are found in rather large numbers in most samples of ginned lint, although rarely in yarn. They have very few fibers and therefore cannot cling to the lint tenaciously; consequently, they drop out during the early stages of processing.

Fragments from small and from large motes are, for the most part, produced in the same way. During cleaning, ginning, or the early stages in yarn manufacturing up to and including carding, the seed portions of many motes, both large and small, are broken. It is also possible that some chalazal chipping may occur in the largest motes. Some of the fragments are small enough to persist in the yarn.

Both large and small motes possess certain seedcoat and fiber characteristics that will aid in fragment identification (*12*). The seedcoat tissue of large motes is light colored in contrast with the dark-colored tissue of mature seeds and of small motes from mature bolls. The fibers are longer than those on small motes and sometimes may be nearly as long as those on mature seeds, and though the degree of fiber-wall development may vary considerably, the walls, on the whole, are usually much thinner than those of fibers on mature seeds or on most small motes. The walls of the fuzz fibers may or may not be thickened. Fragments from large motes may thus usually be identified by the light color of the seedcoat tissue, by the attached bases of broken thin-walled fibers, and in some instances by the presence of thin-walled fuzz fibers (fig. 2, *D*).

Fragments from small motes may be identified by the dark-colored immature mote (seedcoat) tissue and by the short, densely packed, fairly thick-walled fibers (fig. 2, *E*). These closely packed fibers with their fairly straight bases are in sharp contrast with the more widely separated and much contorted fuzz fibers on mature seeds (fig. 1, *C*), and serve to distinguish small-mote fragments from the seed fragments with which they might be confused because of similarity in color of the seedcoat tissue.

False motes are very small, motelike structures that occur at the base of many locks of cotton (*11*). Each consists of a dark-colored seedlike body to which short, thick-walled fibers are attached. They are no larger than some seed and mote fragments and therefore are here classed with the seedcoat fragments. They differ from true seedcoat fragments of similar size in that the seedlike body is an entire structure with its surface unbroken except at the point of attachment. However, structures definitely identified as false motes have been found only occasionally in yarn. Either most of them were large enough to be removed by the card, or they were not recognized in slivers, rovings, or yarns. The possibility that some may be broken during the early stages of yarn manufacturing, especially during carding and combing, cannot be disregarded, but because of their very small size, fragmentation does not seem likely to occur, at least not to any appreciable extent. False-mote fragments would be difficult to distinguish from small-mote fragments and from certain seed fragments.

These descriptions apply to seed and mote fragments from mature bolls and would seem to make fragment identification a simple matter. However, the characteristics and distinctions are not so clear cut as the descriptions might imply, for there are fragments that do not appear to belong to any one of the described classes. Fragments of seeds and motes from insect-damaged, diseased, or immature bolls do not fit into the classification; their fibers are usually thin-walled and their seedcoat tissue differs in general characteristics from that of seeds and motes in healthy bolls.

Considerable study of the fibers and tissue of the seeds and motes from healthy, diseased, and immature bolls is necessary in order to be able to classify a fragment with even a reasonable degree of assurance. On the whole, however, the number of questionable fragments encountered usually is not very large and in this particular study were so few that they were completely disregarded.

A classification of seedcoat fragments has also been presented by Gulati (*4*). He divides them into three groups, the division being based on whether the fuzz is mature, half mature, or immature, and states that the degree of maturity of the fuzz indicates the origin of the fragment. It is difficult to see how, by this system, that fragments from small motes could be distinguished from fragments of mature seeds, since the fibers on small motes from mature bolls are usually thick-walled as are also the short, fuzz fibers on mature seeds.

## Variations in and Relationships of the Number of Seedcoat Fragments in Yarn

### Materials and Methods

Variations in the number of seedcoat fragments in yarns and the relationships of these variations were studied in connection with the 1935–37 regional cotton variety investigations of the Field Crops Research Branch, then a part of the Bureau of Plant Industry, Soils, and Agricultural Engineering (*1*). Publications covering certain phases of these investigations (*10, 11, 12*) give details as to materials used and procedures followed for securing most of the seedcoat-fragment data: therefore, only a brief description of materials and methods will be presented at this time.

The materials studied were seed cotton, ginned lint, and yarn samples representing 2 series for each of 16 varieties grown at 8 locations in 3 successive years.[5] The varieties and locations are shown in table 1.

The seedcoat-fragment content of the yarns was ascertained by examining 50 yards of No. 22s yarn for each spinning test lot.[6]

[5] There were 766 spinning test lots instead of 768 (16 x 2 x 8 x 3), since in two instances replicate spinning samples were composited. To facilitate analyses, two 50-yard samples of yarn were examined for these composited lots in order to have an equal number of observations for all lots. There was one instance of compositing of seed cotton and ginned lint samples. In each instance the value obtained for the composited sample was assigned to the two replications.

[6] Imperfection counts were made by Mary Butler, assistant chemist, Field Crops Research Branch.

The examination was made a yard at a time, and neps, seedcoat fragments, and other imperfections were removed and placed on a black-velvet board (*10*). A certain amount of identification and classification of the imperfections could be accomplished with the unaided eye, but a classification of seedcoat fragments as to type required a microscopical examination. Three types of fragments were considered—chalazal fragments, and fragments from large and from small motes.

TABLE 1.—*Neps and seedcoat fragments in 50 yards of No. 22s yarn for 2 series each of 16 varieties of cotton grown at 8 locations for 3 successive years*

| Variety, location, and year | Neps | Seedcoat fragments | |
|---|---|---|---|
| | *Number* | *Number* | *Percent* [1] |
| Variety (48 observations each): | | | |
| Acala (Rogers) | 48. 4 | 18. 5 | 27. 7 |
| Arkansas 17 | 36. 3 | 11. 6 | 24. 2 |
| Cleveland (Wannamaker) | 14. 8 | 9. 4 | 38. 8 |
| Cook 912 | 25. 6 | 14. 5 | 36. 2 |
| Delfos (Missdel) 4 | 34. 6 | 9. 5 | 21. 5 |
| Deltapine 11 | 29. 2 | 8. 0 | 21. 5 |
| Dixie Triumph 759 | 16. 8 | 13. 5 | 44. 6 |
| Farm Relief 2 | 29. 6 | 13. 8 | 31. 8 |
| Half and Half | 15. 2 | 10. 6 | 41. 1 |
| Mexican Big Boll | 36. 0 | 10. 8 | 23. 1 |
| Qualla | 28. 5 | 10. 9 | 27. 7 |
| Rowden 40-2088 | 20. 8 | 12. 8 | 38. 1 |
| Startex 619 | 16. 9 | 10. 1 | 37. 4 |
| Stoneville 5 | 24. 1 | 10. 3 | 29. 9 |
| Triumph (Oklahoma) 44 | 19. 8 | 12. 8 | 39. 3 |
| Wilds 5 | 89. 4 | 9. 5 | 9. 6 |
| Location (96 observations each): | | | |
| Florence, S. C. | 31. 2 | 10. 7 | 25. 5 |
| Stoneville, Miss. | 27. 7 | 11. 5 | 29. 3 |
| Marianna, Ark. (upland) | 28. 2 | 11. 6 | 29. 1 |
| Marianna, Ark. (delta) | 19. 3 | 11. 2 | 36. 7 |
| Baton Rouge, La | 41. 0 | 12. 1 | 22. 8 |
| Stillwater, Okla. | 49. 3 | 16. 8 | 25. 4 |
| College Station, Tex | 27. 0 | 9. 8 | 26. 6 |
| Lubbock, Tex. | 19. 3 | 9. 7 | 33. 4 |
| Year (256 observations each): | | | |
| 1935 | 23. 2 | 11. 0 | 32. 2 |
| 1936 | 36. 4 | 11. 0 | 23. 2 |
| 1937 | 31. 6 | 12. 9 | 29. 0 |
| Mean (768 observations) | 30. 4 | 11. 6 | 27. 6 |

[1] Percentage values are based on averages given in the table.

Variations in the source of each type of fragment was established from the study of samples of ginned lint and seed cotton. The extent of chalazal chipping was shown for each cotton by the number of large chalazal fragments in a 22-gram sample of the ginned lint (*13*). Mote-forming tendencies were shown by the percentage of both large and small motes in 1,000-seed (seeds + motes) samples. Details of the methods used to obtain the mote percentages are given by Pearson (*12*). The data for the large motes given in that bulletin are somewhat different from those used here, however. In the former study, interest was centered on differences in the production of large motes that could be attributed to differences in variety, location, and season of growth. Large motes suspected of having been formed as the result of insect injury were not included. In the present study all large motes are considered, regardless of causal factors, since all would be potential sources of fragments.

It should be emphasized that the mote-percentage data represent the abundance of motes in seed cotton. No information is available as to the mote content of the ginned lint. With uniform ginning procedures, however, it would be reasonable to assume that differences in the mote content of seed cotton would be shown by similar differences in the mote content of the corresponding lots of ginned lint. Though an effort was made for all sampling and mechanical procedures connected with the regional variety investigations to be as uniform as possible, as will be pointed out later, there probably did occur differences in handling that may have resulted in some inconsistencies among the final results.

The data were subjected to variance and covariance analyses. To facilitate these analyses the values for each pair of replications (series 1 and 2) (see p. 7) were totaled or averaged, since the studies on the nep content of yarn (*10*) and the mote content of seed cotton (*12*) had shown no highly significant differences between blocks within locations. There are thus 384 cottons with 383 degrees of freedom.

It is realized that most, if not all, of the varieties on which this study was based are no longer grown as such. But any group of seed cottons would undoubtedly show variations in chalazal chipping tendencies and in mote content similar to the variations shown by the 16 varieties used for this study. It would therefore be reasonable to assume that the relationships described here would be essentially the same for any other group of cottons under a similar set of conditions.

## Observations on Seedcoat Fragments

The number of seedcoat fragments, regardless of type, in 50 yards of No. 22s yarn for the 384 cottons ranged from 4 to 43 (average of series 1 and 2). Averages showed striking differences between varieties (table 1), Deltapine 11 having the fewest fragments (8.0) and Acala (Rogers) the most (18.5). Locational differences were comparatively small except that the yarns of Stillwater, Okla., had considerably more fragments than those of any of the other 7 locations. Differences between years were also small.

Since neps and seedcoat fragments together make up in most instances the majority of the small imperfections found in the yarns examined, the percentage of each type of imperfection of the total number is of interest. For these particular 384 lots of yarn taken as a whole, the percentage of seedcoat fragments was 27.6 (table 1). The varietal range was from 9.6 percent for Wilds 5 to 44.6 percent for Dixie Triumph 759, and for all varieties, except Wilds 5, seedcoat fragments comprised at least one-fifth of the total number of neps and seedcoat fragments occurring in the yarns examined (table 1).

Gulati (*4*), working with a group of 21 cottons, found seedcoat fragments to make up 18.8 percent of the total number of small imperfections present in the yarns he examined, which is not greatly different from the 27.6-percent content found for the regional variety cottons. His varietal range of 6.5 to 44.5 percent differs little from the range of 9.6 to 44.6 percent for the 16 varieties of the present study. The percentages of Gulati are based, however, on the total number of imperfections present, including bits of leaf, and the yarns studied ranged in count from Nos. 6s to 40s. On the other hand, the percentages of seedcoat fragments found in the yarns of the regional variety studies are based only on the total number of neps and seedcoat fragments, and the entire study was made on No. 22s yarns. Even with these differences in procedures, the two sets of data may be compared in a general way, for the number of leaf fragments found by Gulati were, on the whole, too few to affect appreciably the seedcoat fragments percentages; furthermore, there is no evidence to suggest that the ratio of neps to seedcoat fragments would be affected by the yarn count.

When the individual types of fragments were considered separately, each was found to vary considerably among the 384 lots of cotton. Each type showed striking varietal differences but rather small locational and seasonal differences (table 2). The varietal, locational,

TABLE 2.—*Types of seedcoat fragments in 50 yards of No. 22s yarn for 2 series of each of 16 varieties of cotton grown at 8 locations for 3 successive years*

| Variety, location, and year | Chalazal fragments | Large-mote fragments | Small-mote fragments |
|---|---|---|---|
| | *Number* | *Number* | *Number* |
| Variety (48 observations each): | | | |
| Acala (Rogers) | 1.8 | 6.4 | 10.3 |
| Arkansas 17 | 2.5 | 3.7 | 5.4 |
| Cleveland (Wannamaker) | 1.9 | 2.6 | 4.9 |
| Cook 912 | 6.5 | 2.9 | 5.1 |
| Delfos (Missdel) 4 | 2.1 | 3.1 | 4.3 |
| Deltapine 11 | 2.2 | 2.4 | 3.4 |
| Dixie Triumph 759 | 4.6 | 3.1 | 5.8 |
| Farm Relief 2 | 3.1 | 4.4 | 6.3 |
| Half and Half | 3.8 | 2.6 | 4.2 |
| Mexican Big Boll | 1.9 | 3.2 | 5.7 |
| Qualla | 2.7 | 3.0 | 5.2 |
| Rowden 40-2088 | 3.9 | 3.3 | 5.6 |
| Startex 619 | 2.2 | 2.4 | 5.5 |
| Stoneville 5 | 1.8 | 2.9 | 5.6 |
| Triumph (Oklahoma) 11 | 3.7 | 3.3 | 5.8 |
| Wilds 5 | .2 | 2.5 | 6.8 |
| Location (96 observations each): | | | |
| Florence, S. C | 2.7 | 2.9 | 5.1 |
| Stoneville, Miss | 2.9 | 3.2 | 5.4 |
| Marianna, Ark. (upland) | 2.7 | 3.3 | 5.6 |
| Marianna, Ark. (delta) | 3.2 | 2.7 | 5.3 |
| Baton Rouge, La | 2.9 | 3.6 | 5.6 |
| Stillwater, Okla | 2.8 | 5.2 | 8.8 |
| College Station, Tex | 2.2 | 2.7 | 4.9 |
| Lubbock, Tex | 3.0 | 2.4 | 4.3 |
| Year (256 observations each): | | | |
| 1935 | 3.8 | 3.2 | 4.0 |
| 1936 | 2.2 | 3.0 | 5.8 |
| 1937 | 2.1 | 3.5 | 7.0 |
| Mean (768 observations) | 2.8 | 3.2 | 5.6 |
| Percentage of total number of neps and seedcoat fragments [1] | 6.7 | 7.6 | 13.3 |

[1] See table 1.

and seasonal differences shown by one type of fragment were not necessarily shown by the other two types. For example: Acala (Rogers) had large numbers of fragments from both large and small motes but a small number of chalazal fragments: Cook 912, on the other hand, had a large number of chalazal fragments but about an average number of fragments from large and from small motes. Variance analyses showed, however, that there were highly significant varietal, locational, and seasonal differences in the number of each fragment type in the yarns studied (table 3).

TABLE 3.—*Variance analysis of (1) the number of large chalazal fragments in 22-gram samples of ginned lint and the percentages of large and of small motes in 1,000-seed samples of seed cotton and (2) the number of small fragments from each of these fragment sources in 50 yards of No. 22s yarn for 16 varieties of cotton grown at 8 locations for 3 successive years*

| Source of variation | Degree of freedom | Mean square for— | | | | | |
|---|---|---|---|---|---|---|---|
| | | Chalazal fragments | | Large motes | | Small motes | |
| | | Number of large fragments in lint [1] | Number of fragments in yarn [1] | Percent in seed cotton [1] | Number of fragments in yarn [1] | Percent in seed cotton [1] | Number of fragments in yarn [1] |
| Varieties | 15 | 416. 0** | 50. 3** | 18. 3** | 23. 2** | 87.4** | 54.0** |
| Locations | 7 | 230. 8** | 4. 9** | 65. 5** | 35. 5** | 232.4** | 88.6** |
| Years | 2 | 378. 4** | 91. 8** | 54. 5** | 6. 6** | 70.0** | 308.7** |
| Variety × location | 105 | 13. 5** | 1. 7* | . 8 | 1. 1 | 2.6** | 2.0 |
| Variety × year | 30 | 21. 7** | 6. 4** | 1. 4** | 7. 0** | 2.1 | 10.4** |
| Year × location | 14 | 80. 9** | 3. 5** | 28. 4** | 8. 8** | 64.0** | 22.8** |
| Error | 210 | 7. 2 | 1. 2 | . 7 | 1. 2 | 1.4 | 2.8 |

[1] One asterisk indicates significance at the 5-percent level; 2 asterisks indicate significance at the 1-percent level.

The abundance of each fragment source likewise varied considerably among the 384 lots. Varietal differences were very striking both in the number of chalazal fragments in the ginned lint and in the percentage of small motes in the seed cotton; varietal differences in the percentage of large motes in the seed cotton and the locational and seasonal differences for all three fragment sources were not particularly marked (table 4). When the data were analyzed statistically, however, each fragment source was shown to vary to a highly significant degree with variety, location, and season of growth.

No attempt is made to discuss the interactions for either the fragments or their sources (table 3). The situations are very complex, because of the many factors involved, and interpretations would be difficult, if not impossible, to make.

Correlation analyses showed that there was a highly significant tendency for differences among the 384 cottons in the number of large chalazal fragments in the ginned lint and the percentage of large and of small motes in the seed cotton to be followed by similar differences in the number of the respective fragment types in the corresponding yarns. None of the correlation coefficients are large, however, but the degrees of freedom are sufficient in number to make each coefficient highly significant from a statistical standpoint. The relationship between the abundance of the fragment source and the number of fragments in the yarn was most consistent for chalazal fragments ($r=0.514$), somewhat less for large motes and their fragments ($r=0.471$), and considerably less for small motes and their fragments ($r=0.287$).

Through covariance analyses, the varietal, locational, and seasonal relationships were considered separately for each fragment type and both the total and the "within" correlation coefficients were calculated

TABLE 4.—*Seedcoat fragments in 22-gram samples of ginned lint and large and small motes in 1,000-seed samples of seed cotton for 2 series of each of 16 varieties of cotton grown at 8 locations for 3 successive years*

| Variety, location, and year | Large chalazal fragments in ginned lint | Large motes in seed cotton | Small motes in seed cotton |
|---|---|---|---|
| Variety (48 observations each): | *Number* | *Percent* | *Percent* |
| Acala (Rogers) | 3.0 | 6.1 | 12.0 |
| Arkansas 17 | 4.2 | 4.7 | 8.2 |
| Cleveland (Wannamaker) | 5.2 | 3.8 | 10.7 |
| Cook 912 | 13.6 | 3.7 | 9.4 |
| Delfos (Missdel) 4 | 3.7 | 4.5 | 10.0 |
| Deltapine 11 | 6.1 | 4.2 | 7.7 |
| Dixie Triumph | 7.6 | 4.2 | 8.2 |
| Farm Relief 2 | 5.1 | 6.2 | 10.5 |
| Half and Half | 16.0 | 4.2 | 14.6 |
| Mexican Big Boll | 3.2 | 5.0 | 7.7 |
| Qualla | 6.2 | 4.7 | 11.8 |
| Rowden 40–2088 | 11.6 | 4.7 | 8.2 |
| Startex 619 | 6.5 | 4.2 | 10.1 |
| Stoneville 5 | 5.3 | 3.6 | 9.8 |
| Triumph (Oklahoma) 44 | 9.7 | 5.0 | 8.3 |
| Wilds 5 | 0.1 | 6.0 | 11.4 |
| Location (96 observations each): | | | |
| Florence, S. C | 9.3 | 5.0 | 8.7 |
| Stoneville, Miss | 6.3 | 4.8 | 10.9 |
| Marianna, Ark. (upland) | 4.7 | 4.9 | 9.7 |
| Marianna, Ark. (delta) | 6.7 | 3.3 | 9.8 |
| Baton Rouge, La | 8.1 | 5.8 | 7.1 |
| Stillwater, Okla | 4.6 | 6.4 | 14.7 |
| College Station, Tex | 4.0 | 4.7 | 9.2 |
| Lubbock, Tex | 9.8 | 2.9 | 9.4 |
| Year (256 observations each): | | | |
| 1935 | 8.6 | 4.6 | 9.6 |
| 1936 | 5.3 | 4.2 | 10.8 |
| 1937 | 6.2 | 5.4 | 9.4 |
| Mean (768 observations) | 6.7 | 4.7 | 9.9 |

(table 5). The degree of relationship as shown by the size and significance of the different correlation coefficients varied considerably and was not always what might have been expected from the results of the variance analyses (table 3). For example, highly significant varietal differences were shown for both the percentage of small motes in seed cotton and the number of small-mote fragments in yarn; there was, however, no significant tendency for the varietal differences in the mote percentages to be followed by similar differences in the number of small-mote fragments in yarn (tables 3 and 5).

No attempt will be made to discuss the results of the covariance analyses in detail. However, the following general trends may be observed: Highly significant correlations were given by chalazal fragments for varieties and seasons but not for locations: by large-mote fragments for varieties and locations and to some degree for seasons; and by small-mote fragments for locations only.

There are probably several explanations as to why certain of the very large differences among cottons in the chalazal-fragment content of the ginned lint and the mote content of the seed cotton were not shown by similar differences in the number of the respective fragment type in the corresponding yarns. Some of these inconsistencies may have resulted from inherent differences among the cottons; others may be attributed to factors or conditions associated with the experimental procedures.

TABLE 5.—*Simple correlation coefficients resulting from covariance analysis showing for each of three types of seedcoat fragments the relation between the abundance of the fragment source and the number of fragments in corresponding yarns for 16 varieties of cotton grown at 8 locations for 3 successive years*

| Sources of variation | Degrees of freedom | Correlation coefficients between [1] | | |
|---|---|---|---|---|
| | | Number of large chalazal fragments in ginned lint and number of small chalazal fragments in yarn | Percentage of large motes in seed cotton and number of large-mote fragments in yarn | Percentage of small motes in seed cotton and number of small-mote fragments in yarn |
| Varieties | 14 | 0.820** | 0.592* | 0.205 |
| Locations | 6 | .551 | .840** | .805* |
| Years | 1 | .986 | .997* | −.204 |
| Between varieties within locations | 119 | .685** | .466** | .191* |
| Between varieties within years | 44 | .752** | .398** | .144 |
| Between locations within varieties | 111 | .224* | .655** | .668** |
| Between locations within years | 20 | .208 | .777** | .612** |
| Between years within varieties | 31 | .699** | .121 | .092 |
| Between years within locations | 15 | .509* | .735** | .129 |

[1] One asterisk indicates significance at the 5-percent level; 2 asterisks indicate significance at the 1-percent level.

Lack of varietal correlation appears in some instances to be due to some not understood varietal characteristics that affects the tenacity with which fragments are held by or cling to the lint. For example, both Acala (Rogers) and Wilds 5 produced about the same number of large motes (6.1 and 6.0 percent, respectively, table 4); scatter diagrams with regression lines (not presented here) showed, however, that Acala (Rogers) retained more fragments from this source than would be expected, while Wilds 5 retained fewer (table 2). This behavior characterized the varieties not only when considered as a whole, but also when grown at the various locations in the 3 years. No convincing explanation for the difference in behavior of these two varieties is apparent.

The very poor varietal correlations between the small motes and their fragments (table 5) can be attributed largely to the behavior of Acala (Rogers) and Half and Half. As shown by scatter diagrams and regression lines (not presented here), Acala (Rogers), as with the large motes, retained more fragments of the small motes than would be expected, while Half and Half retained fewer. The small-mote fragments of Half and Half may have been unable to cling tenaciously to the short, coarse fibers that characterize this variety. This explanation is further supported by the fact that Half and Half also retained fewer chalazal fragments than would be expected. Still, the explanation is open to question, since the variety retained about as many large-mote fragments as the mote percentages would indicate. Although there appears to be no adequate explanations for these inconsistent source-fragment relationships among varieties, the consistent behavior of the varieties at the different locations in the different years would indicate that distinct varietal characteristics of some kind are responsible for the retention in the yarn of more or fewer fragments than would be indicated by the relative abundance of the structures giving rise to the fragments.

Time and space do not permit an extensive discussion of discrepancies that undoubtedly originated in the experimental procedures. However, certain rather obvious sources of error should be pointed out. Though an effort was made to have all samples as representative as possible and as large as time and labor would permit, the sampling procedures and sample size, particularly of the yarn, probably constitute important sources of error. Though a 50-yard sample of yarn was considered sufficiently large for the nep phase of the study (*10*), larger samples undoubtedly would have been better for the seedcoat-fragment phase, since each type of fragment occurs in much fewer numbers and apparently with greater variation than do neps.

The possibility of mistaken fragment identification cannot be disregarded. It is felt, however, that such instances would be too few to affect to any appreciable extent the general reliability of the data.

The values representing the number of large chalazal fragments in the ginned lint may be open to some question. It is doubtful that any fragments would be missed in examining the lint samples. It is possible, however, that some may have been broken up, so what should have been counted as 1 fragment (the tuft from 1 seed) was counted as 2 or even 3 fragments.

Instances, particularly of locational relationships, in which the chalazal-fragment content of the lint appears to be too high for the fragment content of the yarn, could possibly be attributed to a breaking up of chalazal tufts by certain methods of handling (tables 2 and 4).

It is possible that preginning, ginning, and postginning treatments and methods of handling may have varied sufficiently from location to location and from year to year to account for some of the discrepancies observed. For example, about the same number of small motes were produced in each of the 3 years and yet the 1937 yarns contained more small-mote fragments than did the 1935 and 1936 yarns (tables 2 and 4). It is possible that when ginning some, if not all, of the 1937 cottons, the moting action was restricted to a greater degree than in the other 2 years, so that the 1937 lints possessed more small motes and the yarns consequently more fragments from small motes than did the lints and yarns of 1935 and 1936.

In spite of the inconsistencies, it is evident, however, that the seedcoat fragment content of a yarn is related to the number of large chalazal fragments and motes in the lint from which the yarn is spun, and that differences among yarns in their seedcoat-fragment content result to a significant degree from varietal, locational, and seasonal differences in the chalazal chipping and mote-forming tendencies of the cottons concerned.

## Discussion

Failure to distinguish seedcoat fragments from neps leads to confusion and misunderstanding, and may affect procedures followed by ginners and yarn manufacturers, but particularly by breeders. If seedcoat fragments are not distinguished from neps, they will enter into the nep count, so that erroneous conclusions may on occasion be reached as to factors responsible for the appearance of specific samples of yarn. The yarn spun from a certain selected strain might be considered very neppy, whereas it actually had few neps but numerous chalazal fragments. Failure to recognize this fact would lead the breeder to attempt to select for low-nep production, whereas he should select strains with reduced tendencies to chalazal chipping.

Neppiness is generally associated with long- and fine-fibered cottons and with immaturity as represented by a high percentage of immature seeds, large motes, and thin-walled fibers. Such immature cottons would probably also yield excessive numbers of seedcoat fragments. However, as chalazal chipping and mote-forming tendencies have been shown to vary considerably among the varieties studied (table 3), the production of an excessive number of seedcoat fragments may or may not be associated with excessive nep formation. Thus, an abundance of small imperfections not associated with conditions conducive to nep formation would probably indicate a problem of seedcoat fragments.

Failure of the breeder to distinguish between seedcoat fragments and neps, and to recognize this fragment production as a problem distinctly different from that of nep formation may lead not only to a loss of time but to failure to develop strains of cotton possessing desired characteristics.

Controlling or reducing the seedcoat fragments in lint and yarn is more than a matter of breeding. Though some reduction in mote-forming and chalazal tendencies can undoubtedly be brought about by breeding for small chalazal-cap areas and for low-mote production, further control or reduction could be accomplished by employing ginning practices that would tend to reduce the extent of chalazal chipping and to increase the number of motes removed.

It must be borne in mind, however, that unfavorable environmental conditions could probably result in increased mote formation, even for a variety tending under favorable conditions to produce few motes. It should also be borne in mind that the inter-relationships among the different factors that control the growth and development of the cotton plant, the seed, and the fiber may be such that reduction in mote-forming and chalazal-chipping tendencies could not be carried beyond a certain point, without emphasizing some related, undesirable characteristic.

There is finally the question of evaluating the importance of seedcoat fragments as an element of yarn quality. Precise evaluations are difficult to make. No method has been developed other than to count them in measured lengths of yarn, or samples of lint, silver, or roving of known weights (*4, 7*).

The importance of the seedcoat fragments would probably depend upon the actual number of fragments occurring in a yarn, as well as upon this number in relation to the total number of imperfections of similar size. For example, it would be reasonable to suppose that the seedcoat-fragment content would have a more important quality-determining effect in Half and Half than in Acala (Rogers), for though the Half and Half yarns had only 10.6 fragments per 50 yards as compared with 18.5 for Acala (Rogers), the percentage content for Half and Half was 41.1, while that for Acala (Rogers) was only 27.7 (table 1).

The possible importance of fragment size should be taken into consideration. A few large fragments because of their conspicuousness might detract more from yarn appearance than would a greater number of smaller fragments. However, large fragments may not constitute a very important quality problem. They are usually very insecurely attached to the surface of the yarn and many would be lost in the finishing processes. Smaller and less conspicuous fragments that are more closely incorporated in the yarn might prove to be more troublesome.

It is difficult to draw general conclusions as to which type of fragment detracts most from yarn quality, as their numbers vary greatly from lot to lot. For these particular cottons as a whole, the fragments from small motes might be considered the most important type, for they comprised practically half of the fragments present. However, fragments from large motes, even though fewer in number, would probably have an effect on yarn quality at least equal to all the other fragments, because of the dyeing difficulties with their tufts of thin-walled fibers.

It is evident from these observations that the problem of seedcoat fragments is a very definite one, but that it is far from a simple one, being complicated by the interaction of many factors associated with problems of breeding, production, manufacturing, and finishing.

## Summary

Seedcoat fragments as they occur in yarn are similar in size to neps and present some of the same quality problems plus a few additional ones. They are usually less abundant than neps, but may occasionally make up nearly half of the neplike imperfections in a yarn.

There are three main types of fragments, each from a distinctly different source: (1) Chalazal fragments, small fragments that are separated from the larger ones pulled from the chalazal ends of the seeds during ginning, (2) fragments from large motes, and (3) fragments from small motes. The mote fragments are produced by the breaking of motes during ginning or the early stages of processing up to and including carding. Each fragment type possesses certain fiber and seed-tissue characteristics, which will, in most instances, serve for identification purposes.

Variations in each fragment type and its source were studied on ginned lint, and on seed-cotton and yarn samples representing 2 series for each of 16 varieties grown at 8 locations for 3 successive years. Each fragment type and its source was shown to vary to a highly significant degree with variety, location, and season of growth. In general, there was a highly significant tendency for variations among the cottons in the abundance of each fragment source to be followed by similar differences in the fragment content of the corresponding yarns. Varietal differences were shown with a high degree of consistency by chalazal and large-mote fragments, but not by small-mote fragments; locational differences by both large- and small-mote fragments, but not by chalazal fragments; and seasonal differences to some degree of significance by chalazal and large-mote fragments, but not by small-mote fragments.

Possible explanations for the failure of certain differences in the abundance of a fragment source (the number of chalazal fragments in the ginned lint or the percentage of large or of small motes in the seed cotton) to be shown by similar differences in the fragment content of the corresponding yarns were discussed.

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