

5-30-1958

# A Distributional and Taxonomic Study of *Ratibida Columnifera* Var. *Columnifera*, *Ratiba Columnifera* Var. *Pucherrima*, and Their Hybrids in New Mexico

Walter W. Marshall

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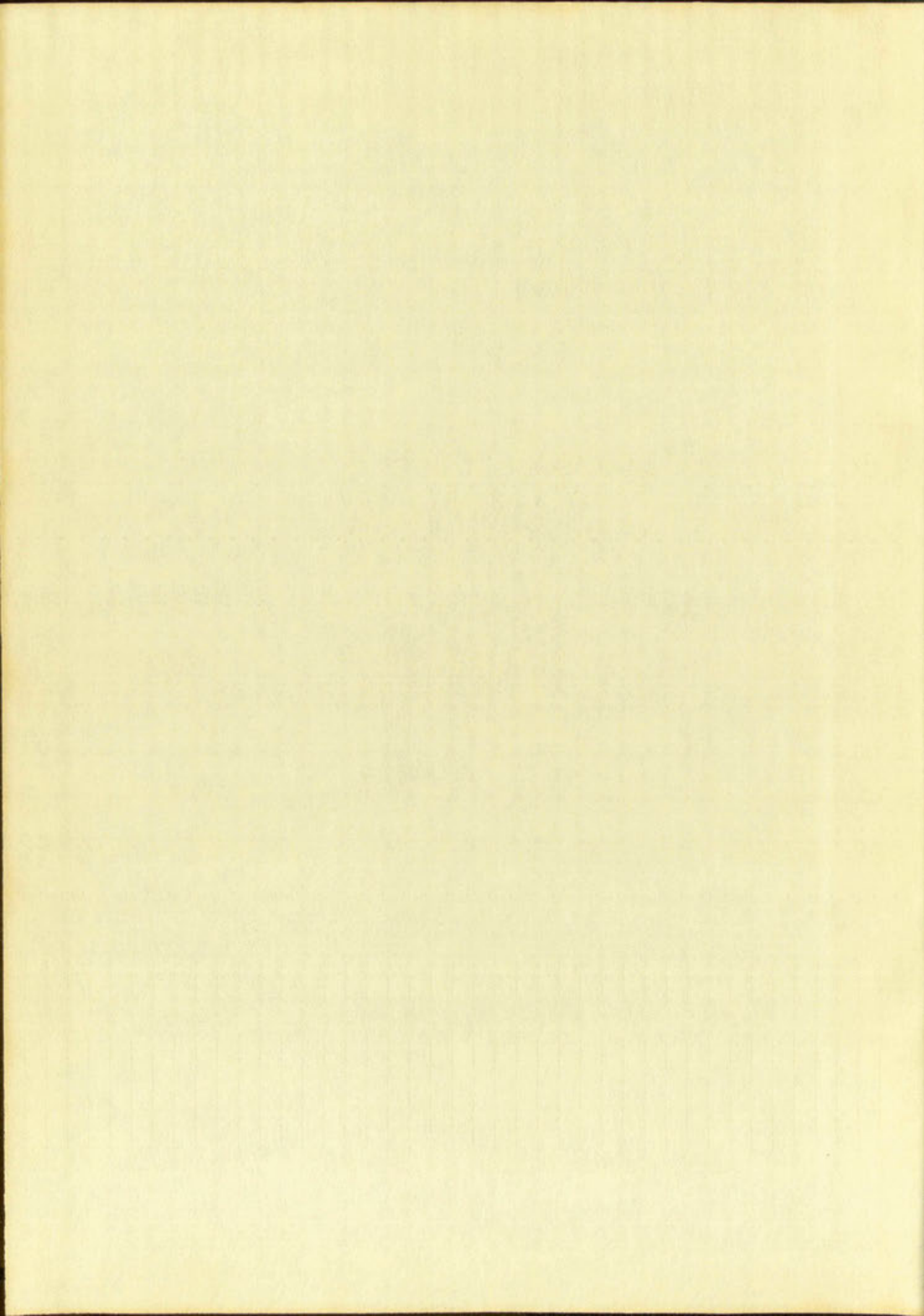


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A DISTRIBUTIONAL AND TAXONOMIC STUDY OF  
RATIBIDA COLUMNIFERA VAR. COLUMNIFERA,  
RATIBIDA COLUMNIFERA VAR. PULCHERRIMA,  
AND THEIR HYBRIDS IN NEW MEXICO

by

Walter W. Marshall

A Thesis

Submitted in Partial Fulfillment of the  
Requirements for the Degree of  
Master of Science in Biology

The University of New Mexico

1958



A HISTORICAL  
NATIVE  
AND  
MILITARY

Walter S. Wadsworth

Submitted in partial fulfillment of the  
Requirements for the degree of  
Master of Science in History

The University of California  
1923



This thesis, directed and approved by the candidate's committee, has been accepted by the Graduate Committee of the University of New Mexico in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

*E. H. Castetter*

DEAN

*May 30, 1958*

DATE

Thesis committee

*R. Jackson*

CHAIRMAN

*William J. Foster*

*Howard R. Hutter*



For the purpose of the present study, the following  
method has been adopted: the study of the  
University of New South Wales, Australia, and  
results for the year 1963.

May 20, 1963

Dear Sir,

I am pleased to hear from you and  
thank you for your letter of the 14th inst.  
I am sorry that I cannot give you a more  
definite answer at present, but I am sure  
that I will be able to do so in the near future.

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#### ACKNOWLEDGMENTS

The writer takes this opportunity to express his appreciation to those who have made this work possible. Particularly is he under obligation to Dr. Raymond C. Jackson, under whose direction and supervision this work has been carried out, for ready and helpful suggestions given throughout this study. Especial gratitude is due Drs. Howard J. Dittmer and William J. Koster for their interest shown in the work and their aid and suggestions in the final preparation of this thesis.

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JOHN WILKINSON

The writer takes this opportunity to express his appreciation to those who have made this work possible. Particularly he is under obligation to Dr. Jackson, under whose direction and supervision this work has been carried out, for ready and helpful suggestions given throughout this study. Special gratitude is due Dr. Howard J. Dwyer and William J. Edwards for their interest shown in this work and their aid and suggestions in the final preparation of this study.

WILKINSON, JOHN  
EVERETT  
COLLEGE CONTENT



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## CHAPTER I

## INTRODUCTION

The classification and distribution of Ratibida columnifera var. columnifera Woot. & Standl. and R. columnifera var. pulcherrima (DC.) Woot. & Standl. are complex. Some floras list R. columnifera var. pulcherrima as a purple colored form or variety of the species while other authors refer to this taxon as separate species of Ratibida. The purpose of this study is to clarify the taxonomic status of the two forms by determining the similarities and differences in morphology, distribution, taxonomy, and ecology.

An attempt has been made to determine the route by which R. columnifera columnifera and R. columnifera pulcherrima were distributed. After this was determined, a theory was formulated which correlated the pattern of distribution with the location of pure populations of the forms.

This problem was limited in its scope to New Mexico. For the sake of clarity, a general survey was made of the distribution of R. columnifera columnifera and R. columnifera pulcherrima in the United States. The purpose of the survey was to determine the possible routes of entry of the forms into New Mexico.





Since color was found to be a major distinguishing characteristic between these forms and their hybrids, an additional analysis was made of the pigments. A correlation was found between R. columnifera columnifera, R. columnifera pulcherrima, and their hybrids on the basis of a color index and a color pattern. An analysis of the color-pattern classes has been made in order to obtain some idea as to the type of inheritance involved.



Since color was found to be a characteristic feature of the material, additional analysis was made of the material. A relation was found between the color and the degree of polymerization, and the color was found to be a function of the color index and a color factor. The relation of the color-pattern observed was also found to be a function of the color index and a color factor. The relation of the color-pattern observed was also found to be a function of the color index and a color factor.

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MILITARY MATTER

## CHAPTER II

## MATERIALS AND METHODS

The dried material used in this study is deposited in the herbarium of the University of New Mexico. A total of 248 specimens were examined. The color photographs of living plants were taken in the field to indicate the general habitats and the color patterns of the species and hybrids.

The following measurements were made of the dried specimens: (1) cone length and width; (2) ray-flower length and width; (3) cone-flower length; (4) achene length. In addition, the following characteristics were noted: (1) number and type of stem ribs; (2) nature, type, and location of leaves; (3) type and location of pubescence.

A quantitative study was made of the ray-flower pigments. Sections weighing 5.0 mgm. were refluxed for 45 minutes in a 10 ml. mixture of equal parts of 95% ethanol and propionic acid, and the sample was removed and permitted to stand at room temperature for three hours. At this time the maximum color was obtained and a reading was made on a Klett-Summerson Colorimeter.







Ideographs (figs. 3-25) were drawn in order to study patterns of color. The size of the ligule was disregarded for the purpose of this analysis because the patterns remained the same general shape regardless of the size of the ligule. Rectangles simulated the general shape of the ligule, and the patterns were in the same proportion found in the ray-flower. It should also be noted that the patterns represented in figs. 4-26 were collected in an area dominated by R. columnifera columnifera which resulted in a dominance of yellow pigment in the pattern. The same patterns but with a dominant purple coloration were present in areas where R. columnifera pulcherrima was the most abundant form.

The fertility of the pollen was determined by staining the pollen grains, dissected from the anthers, with methylene blue in lactophenol for 24 hours according to the method of R. C. Jackson and A. T. Guard. Those pollen grains that exhibited a uniform dark stain were considered fertile. Pollen grains that were of a light uneven stain or did not stain at all were considered non-viable.

One mass collection was taken of a hybrid population. This collection was limited to an area of approximately 625 square yards of open meadow four miles





west of Elk, New Mexico. All plants of R. columnifera  
columnifera, R. columnifera pulcherrima, and their  
hybrids were counted. A sample was collected which was  
proportional to the parental and hybrid types.

## EZEKIAH

## MILITARY FACTS

west of Elk, New Mexico. All about it is a desert.

Calamagrostis, E. setacea, and other

grasses were raised. A number of other plants

proportional to the amount of water.



## CHAPTER III

## TAXONOMY AND ECOLOGY

## A. Description of the Species

RATIBIDA COLUMNIFERA (Nutt.) Woot. & Standl. in Contr. U. S. Nat. Herb. (Fl. N. Mex.) 19:706, 1915.

RATIBIDA COLUMNARIS (Sims) D. Don in Sweet's Brit. Fl. Gard. vii: (Ser. Ziv), t. 361. 1836.

LEPACHYS COLUMNARIS (Sims) Steud. Nom. ed. II, ii, 439. 1895.

Perennial, arising from a horizontal rootstalk; stem simple or branched, hexagonal in cross section with alternate ridges and depressions, strigose hirsute; leaves alternate, pinnately dissected, the basal ones larger; heads solitary and cylindrical; receptacle columnar; disc flowers 3 mm. long with a very short tube, 5-lobed, glabrous; ray-flowers yellow, the tips notched; achenes 2 mm. long, flat, glabrous; pappus coroniform.

RATIBIDA COLUMNIFERA var. PULCHERRIMA (DC.) Woot. & Standl. in Contr. U. S. Nat. Herb. (Fl. N. Mex.) 19:706, 1915.

RATIBIDA COLUMNARIS var. PULCHERRIMA (DC.) D. Don in Sweet's Brit. Fl. Gard. vii (Ser. Ziv), t. 361. 1836.

LEPACHYS COLUMNARIS var. PULCHERRIMA (DC.) Steud. Nom. ed. II, ii, 439. 1895.

Color was found to be the only difference that exists between R. columnifera columnifera and R.

# COLON

RATIBIDA COLUBRARIA (L.) Guss. & Link. 1774  
 Contr. U. S. Nat. Herb. 1: 121. 1845.

RATIBIDA COLUBRARIA (L.) Guss. & Link. 1774  
 Pl. Gand. viti (part. fil.) 1: 121. 1845.

LEUCANTHUS COLUBRARIA (L.) Guss. & Link. 1774  
 459. 1845.

Tormentil, spiraea from a botanical manuscript.

stem simple or branched, terete, with nodes and internodes

alternate ridges and depressions, with fine hairs.

leaves alternate, lanceolate or elliptical, the base

larger; heads solitary and cylindrical; receptacles

columnar; disc flowers 5 mm. long with a very narrow

tube, 5-lobed, glabrous; ray-flowers bell-shaped, the

notched; anthers 2 mm. long, filaments 1 mm.

corolliform.

RATIBIDA COLUBRARIA (L.) Guss. & Link. 1774  
 E. Scand. in Contr. U. S. Nat. Herb. 1: 121. 1845.

RATIBIDA COLUBRARIA (L.) Guss. & Link. 1774  
 in Sweet's Bot. Pl. Gand. viti (part. fil.) 1: 121. 1845.

LEUCANTHUS COLUBRARIA (L.) Guss. & Link. 1774  
 Nov. ed. 11, 459. 1845.

Colt was found as the only plant in the

exists between R. columbiana and R. ...



columnifera pulcherrima. Ratibida columnifera columnifera has pure yellow ligules, while those of R. columnifera pulcherrima are mostly purple (fig. 1). The hybrids between the two have distribution patterns consisting of the two colors found in the parents (fig. 2). The ideographs in figs. 3-25 summarize the typical patterns of pigment found in the hybrids from various populations.

In the citation of specimens, all collected in New Mexico, the following symbols are used for convenience and clarity:

1. P--designates a pure purple population (Ratibida columnifera pulcherrima).
2. Y--designates a pure yellow population (Ratibida columnifera columnifera).
3. X--designates a purple-yellow mixture, considered here as a putative hybrid between the two varieties previously mentioned.

#### B. Specimens Examined

Eddy Co.: roadside drain, 4 mi. east of Hope on U. S. 83, elevation 4100 ft., June 6, 1957, Marshall R2X; roadside drain, 5 mi. east of Hope on U. S. 83, elevation 4000 ft., June 6, 1957, Marshall R1X; railroad right-of-way, east of Artesia city limits, elevation 3400 ft., June 6, 1957, Marshall R4X; roadside drain, west of Hope city limits, elevation 4100 ft., June 6, 1957, Marshall R8P; roadside drain, 5 mi. north of Artesia on U. S. 285, elevation 3400 ft.,





June 7, 1957, Marshall R5X; swampy drain area, west of Artesia city limits, elevation 3300 ft., June 7, 1957, Marshall R3X; roadside drain, Rattlesnake Springs, Carlsbad Caverns, May 22, 1952, Castetter and Dittmer 7272; roadside drain, 5 miles west of Carlsbad, May 18, 1951, Castetter and Dittmer 5268. Lea Co.: roadside drain, west of Caprock on U. S. 380, elevation 3900 ft., June 7, 1957, Marshall R6X; roadside drain, 5 mi. south of Hobbs, June 5, 1952, Castetter 7725. Torrance Co.: roadside drain, Inlow Youth Camp Road in Cibola National Forest, Fourth of July Canyon, elevation 6800 ft., June 28, 1957, Marshall R10P; railroad siding, 14 mi. south of Moriarity on N. M. 41, elevation 6100 ft., July 6, 1957, Marshall R22P; roadside drain, 7 mi. south of Tajique on N. M. 55, elevation 6600 ft., July 6, 1957, Marshall R23P. Bernalillo Co.: roadside drain, 1 mi. south of Cedar Crest, elevation 7500 ft., July 6, 1957, Marshall R20X; roadside drain just above Cedar Crest, elevation 7500 ft., July 6, 1957, Marshall R21P; gravelly soil, Sandia Mountains Fur Farm, July 30, 1937, Abbott 4247; east side of Sandia Mountains, 1 mi. south of Antonito, June 30, 1956, R. C. Jackson 2302-3. Otero Co.: roadside drain, just east of Mescalero on N. M. 24, elevation 7000 ft., July 20, 1957, Marshall R30Y; roadside drain, 1 mi. east of Mescalero on N. M. 83, elevation 7000 ft., July 20, 1957, Marshall R31X;





roadside drain, west of Mayhill on N. M. 83, elevation 7400 ft., July 20, 1957, Marshall R32X; roadside drain, James Canyon Road southeast of Cloudcroft, elevation 7300 ft., July 20, 1957, Marshall R33X; roadside drain, Silver Springs Canyon Road northeast of Cloudcroft, elevation 7800 ft., July 21, 1957, Marshall R34X; open meadow 15 mi. northeast of Cloudcroft on N. M. 24, elevation 7200 ft., July 21, 1957, Marshall R35X; open meadow 4 mi. south of Mescalero on N. M. 24, elevation 7300 ft., July 21, 1957, Marshall R36P; open meadow, 12 mi. south of U. S. 70 on Elk Canyon Road, elevation 7300 ft., July 21, 1957, Marshall R38X; roadside drain, Sixteen Spring Canyon Road, 4 mi. west of Elk Canyon Road, elevation 6800 ft., July 21, 1957, Marshall R40X; banks of Ruidoso Creek, Wingfield Ranch in White Mountains, elevation 6400 ft., July 8, 1895, E. O. Wooton 17982; Cox Canyon, Cloudcroft and Ruidoso, July 3, 1949, Castetter and Dittmer 4478. Valencia Co.: open meadow, 2 mi. west of the ice caves on N. M. 53, elevation 7800 ft., July 27, 1957, Marshall R40X. Rio Arriba Co.: open meadow, 1 mi. north of Cuba on N. M. 126, elevation 7000 ft., July 28, 1957, Marshall R42X; roadside drain, 4 mi. west of Chama on U. S. 84, elevation 7300 ft., Aug. 10, 1957, Marshall R60X; pinyon-juniper, 40 miles south of Tierra Amarilla, July 22, 1949, Castetter and Dittmer 4477. Santa Fe Co.:

roadside drain, east of station 10.7, at station  
 7500 ft., July 21, 1957. Small black beetle, 1.5 mm.  
 Texas Canyon Road, south of station 10.7, at station  
 7500 ft., July 21, 1957. Small black beetle, 1.5 mm.  
 Silver Springs Canyon, road, east of station 10.7,  
 elevation 7500 ft., July 21, 1957. Small black beetle, 1.5 mm.  
 meadow 1/2 mi. northwest of station 10.7, at station  
 elevation 7500 ft., July 21, 1957. Small black beetle, 1.5 mm.  
 meadow 1/2 mi. south of station 10.7, at station  
 7500 ft., July 21, 1957. Small black beetle, 1.5 mm.  
 1/2 mi. south of U. S. 50, at station 7500 ft.,  
 July 21, 1957. Small black beetle, 1.5 mm.  
 Sixteen Spring Canyon, 1/2 mi. south of station  
 7500 ft., July 21, 1957. Small black beetle, 1.5 mm.  
 Bank of Redwood Creek, elevation 7500 ft., July 21, 1957.  
 Mountain, elevation 7500 ft., July 21, 1957.  
 Weston 1957; Cox Canyon, elevation 7500 ft., July 21, 1957.  
 3, 1949, Gaster and Dittmer. Elaphidion  
 open meadow, 1/2 mi. south of station 10.7, at station  
 elevation 7500 ft., July 21, 1957. Small black beetle, 1.5 mm.  
Elaphidion sp.: open meadow, 1/2 mi. south of station 10.7, at  
 7500 ft., July 21, 1957. Small black beetle, 1.5 mm.  
 roadside drain, 1/2 mi. south of station 10.7, at station  
 7500 ft., July 21, 1957. Small black beetle, 1.5 mm.  
 1/2 mi. south of station 10.7, at station 7500 ft., July 21, 1957.

COLLECTOR COMMENTS  
 EZEKIAH



roadside drain, 16 miles southeast of Santa Fe on U. S. 84, elevation 6900 ft., Aug. 3, 1957, Marshall R50X.

San Miguel Co.: roadside drain, 1 mi. north of Rowe on U. S. 84, elevation 6800 ft., Aug. 3, 1957, Marshall R51X. Union Co.: roadside drain, Don Carlos Ranch 7 mi. east of Gladstone on U. S. 58, elevation 5800 ft., Aug. 3, 1957, Marshall R52X; Bear Canyon, Mescalero Reservation, Aug. 1, 1938, Humphrey 12294; roadside drain, Cimarron Canyon, elevation 8200 ft., July 6, 1935, Castetter 2546; prairies southwest of Kenton, Okla., (just in N. M.), Aug. 9, 1951, Clark 15271; meadow along Cimarron River, east of Folsom, July 24, 1952, Dittmer 9661. Colfax Co.: roadside drain, 8 mi. northeast of Cimarron on U. S. 64, elevation 6600 ft., Aug. 3, 1957, Marshall R53X; pinyon-juniper, rocky ground, Ojo Feliz, Aug. 10, 1949, Gordon and Norris 4549; open areas along Cimarron River, 8 mi. east of Eagle Nest Lake, Aug. 8, 1951, Clark 5865. Taos Co.: open meadow, 1 mi. north of Taos on County Road 3, elevation 6500 ft., Aug. 4, 1957, Marshall R54X. Catron Co.: open woods, east of Aragon, Aug. 17, 1942, Clark 23480; meadow near Apache Creek on Route 12, July 17, 1952, Dittmer 8662. Mora Co.: Solomon Ranch, La Cueva, Sept. 22, 1954, E. Williams 16855. Lincoln Co.: pine-spruce, banks of Bonita Lake, elevation 7500 ft., Aug. 18, 1949, Gordon and Dunn 9550.





### C. Ecology

Both forms can tolerate a dry, semi-arid environment, but neither can thrive there. Plants growing in such habitats are smaller and less numerous than those found in moist areas. The larger populations were found in open meadows, roadside drainage areas, and railroad right-of-ways. These are areas where water would collect and not run off rapidly. A typical habitat is shown in fig. 26.

Both forms grow at an elevation of 3000 feet in the desert plains to 7800 feet in the Jemez Mountains. The optimum elevation appears to be in the range of 6800-7500 feet. The plants are observed to be larger and hardier within this range of elevation.

Ratibida columnifera columnifera and R. columnifera pulcherrima are found in silt-loam soils suitable for grasslands. However, the range of tolerance is great because these forms can also be found in sandy and gravelly types of soil, but under these conditions the size of the plant is small.





Figure 1

Ratibida columnifera columnifera

1900

THE COTTON CONTENT

MILLERS HALL  
EXERASE  
COTTON CONTENT





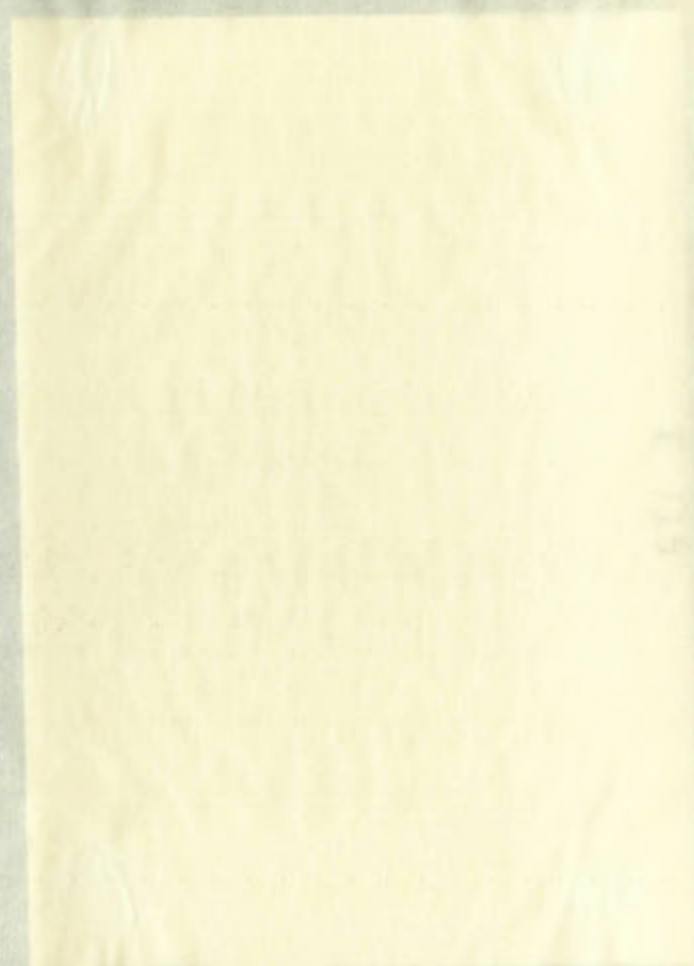




Figure 2

Hybrid between Ratibida columnifera columnifera and  
Ratibida columnifera pulcherrima

Figure 2

Hybrid between *Persea caroliniana* and *Persea*

*caroliniana* (see text)

COLLON CONTENT

PERSEA

PERSEA





E 632



Figures 3 - 25

Ideographs showing the color patterns  
of the hybrids

CONTENTS  
EZEKIEL  
MILERS PAINTS

Figure 1 - 20

Isosceles showing the color balance  
of the figure

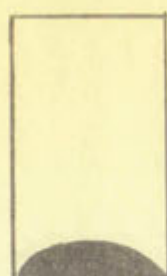




R31X2



R31X4



R31X5



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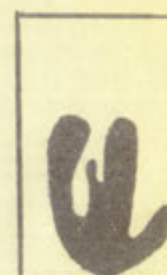
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R32X6



R32X7



R33X1a



R33X1b



R33X2



R33X3



R33X4



R33X5



R33X6



R34X1



R20X1



R20X5



R20X2

KEY TO COLOR:

BLACK INDICATES YELLOW PIGMENT

WHITE INDICATES PURPLE PIGMENT





Figure 26

Habitat of R. columnifera columnifera, R.  
columnifera pulcherrima, and their hybrids

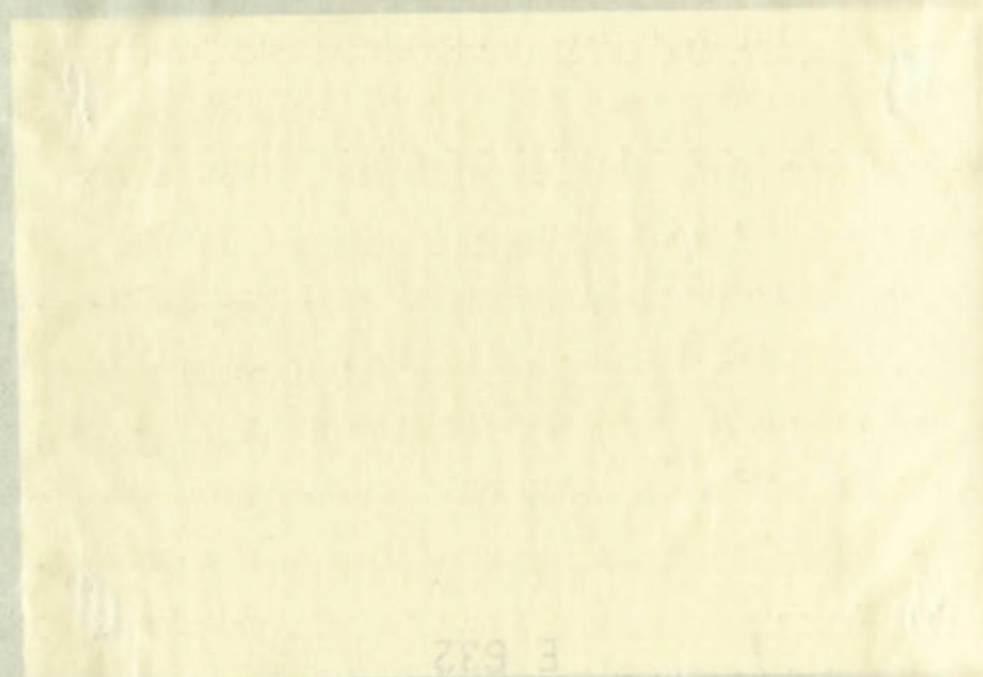
Page 10

History of the Colony of the  
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COLONY OF THE  
EZEKIEL  
MILKERS









## CHAPTER IV

## GEOGRAPHICAL DISTRIBUTION

In order to determine where these forms entered New Mexico, it is necessary to know something of their range (see the map in fig. 27). Sharp (1935, p. 67) defines Nebraska as the center of the range of Ratibida. From there, Ratibida was introduced into the Dakotas and Montana. The genus followed roadsides and railroad right-of-ways into the dry prairies of Texas, New Mexico, and northern Mexico.

No mention of the presence of Ratibida has been noted in any floras for the Atlantic States or for areas west of Arizona. The distribution of R. columnifera columnifera and R. columnifera pulcherrima in the United States is indicated on the map of fig. 27. The map indicating the range of the genus was compiled from the floras of Alabama, Arizona, Colorado, Indiana, Kansas, Minnesota, Nebraska, New Mexico, North Dakota, Oklahoma, South Dakota, Texas, and the State of Chihuahua, Mexico, where Ratibida is located. Fig. 28 indicates the results of a detailed herbarium and field of survey of New Mexico. This survey is supplemented from sources used in the general distributional study.

# NEW MEXICO MILITARY

## GOVERNMENT OF NEW MEXICO

In order to determine the extent of the  
New Mexico, it is necessary to have the  
range (see map on p. 10). The  
definition of the range is as follows:  
From there, the range was  
and Montana. The range followed  
right-of-way line of the  
Mexico, and northern Mexico.

No mention of the presence of  
noted in any of the  
west of Arizona. The  
colleagues and the  
States is indicated on the  
indicating the name of the  
forms of Arizona, Colorado,  
Minnesota, Nebraska, New Mexico,  
South Dakota, Texas, and the  
where the range is located.  
results of a detailed  
New Mexico. This survey is  
used in the report.



Figure 27

Range of Ratibida in the United States

CONTENTS

Page 1

Range of Wetlands in the United States



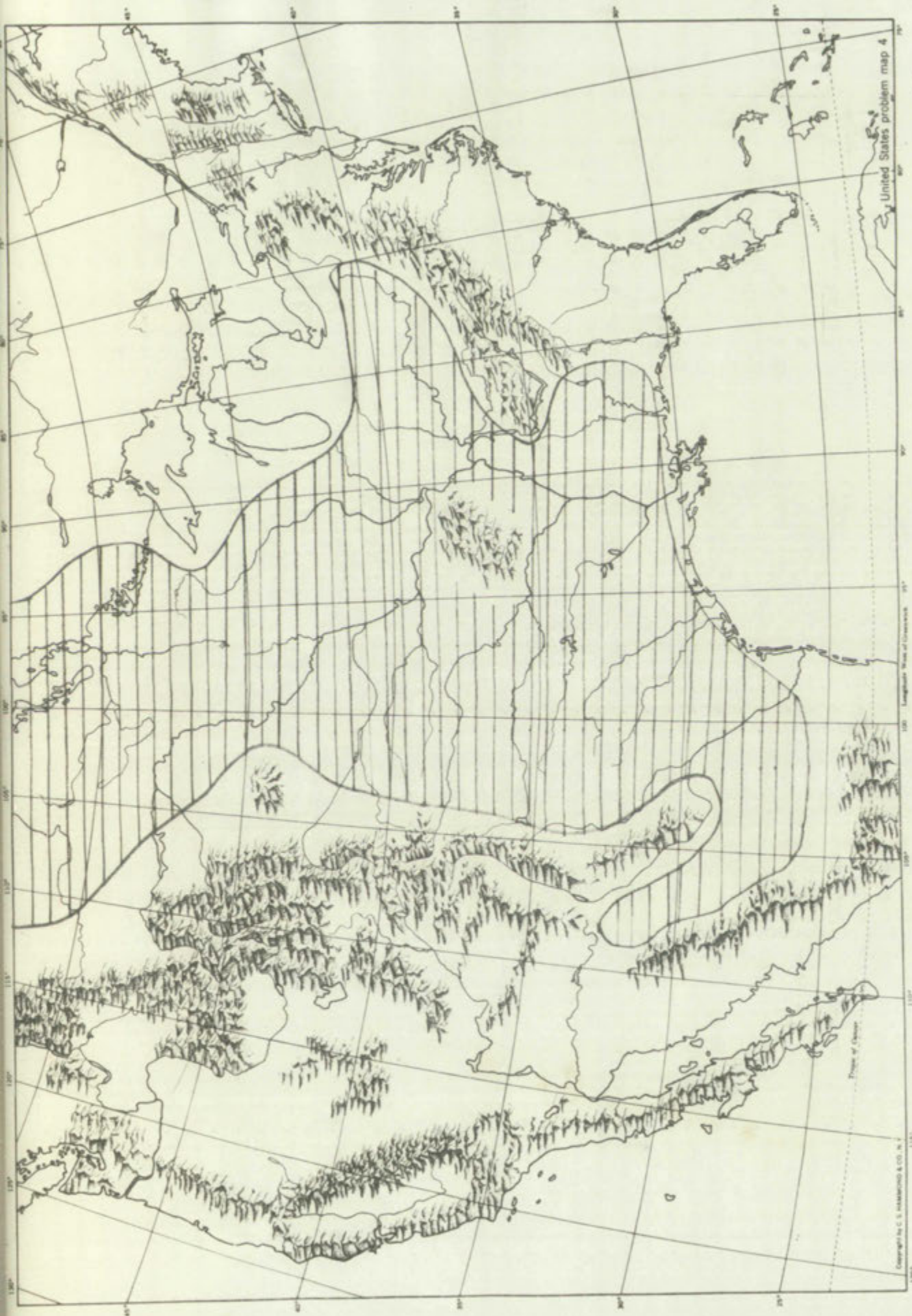






Figure 28

Distribution of Ratibida columnifera  
columnifera and Ratibida columnifera  
pulcherrima in New Mexico

## Key

- o R. columnifera columnifera
- e R. columnifera pulcherrima
- x Hybrids

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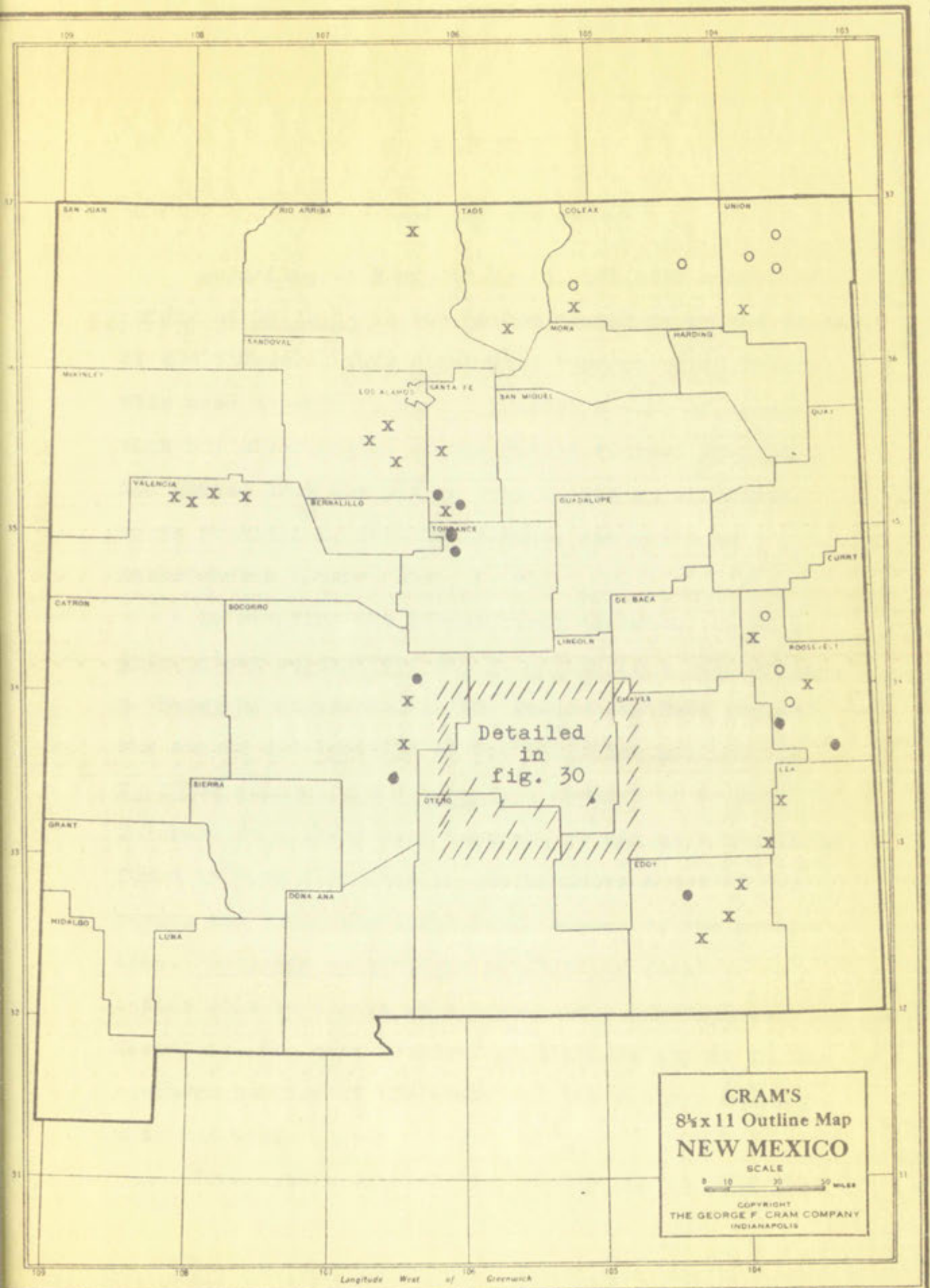
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STATIONER





DISCUSSION AND CONCLUSIONS

According to Shaw (1937, p. 17), the present origin of *Basileia* in the United States is in the Midwest. This conclusion seems valid because this area appears to have a greater number of species than any other region of the United States. *Basileia* has spread from the plains east to the Appalachians, south to Alabama, west to Arizona, and north to Saskatchewan (Shaw, 1937, p. 18).

In studying the geographical distribution of *Basileia columbiana* and *B. columbiana columbiana*, a theory of dispersion in the East is suggested. The manner and location of the migration are indicated. *Basileia columbiana* appears to be more tolerant to a harsher climate and is a resident in the north. It is more abundant in the northern states of New Mexico and along the north-south axis of the United States. *Basileia columbiana columbiana* seems to be better able to thrive in a warmer, more humid climate. Therefore, the more abundant populations of *B. columbiana* in the southern portion of the range and the variety occurring east and west.

From examination of figs. 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 100, 101, 102, 103, 104, 105, 106, 107, 108, 109, 110, 111, 112, 113, 114, 115, 116, 117, 118, 119, 120, 121, 122, 123, 124, 125, 126, 127, 128, 129, 130, 131, 132, 133, 134, 135, 136, 137, 138, 139, 140, 141, 142, 143, 144, 145, 146, 147, 148, 149, 150, 151, 152, 153, 154, 155, 156, 157, 158, 159, 160, 161, 162, 163, 164, 165, 166, 167, 168, 169, 170, 171, 172, 173, 174, 175, 176, 177, 178, 179, 180, 181, 182, 183, 184, 185, 186, 187, 188, 189, 190, 191, 192, 193, 194, 195, 196, 197, 198, 199, 200, 201, 202, 203, 204, 205, 206, 207, 208, 209, 210, 211, 212, 213, 214, 215, 216, 217, 218, 219, 220, 221, 222, 223, 224, 225, 226, 227, 228, 229, 230, 231, 232, 233, 234, 235, 236, 237, 238, 239, 240, 241, 242, 243, 244, 245, 246, 247, 248, 249, 250, 251, 252, 253, 254, 255, 256, 257, 258, 259, 260, 261, 262, 263, 264, 265, 266, 267, 268, 269, 270, 271, 272, 273, 274, 275, 276, 277, 278, 279, 280, 281, 282, 283, 284, 285, 286, 287, 288, 289, 290, 291, 292, 293, 294, 295, 296, 297, 298, 299, 300, 301, 302, 303, 304, 305, 306, 307, 308, 309, 310, 311, 312, 313, 314, 315, 316, 317, 318, 319, 320, 321, 322, 323, 324, 325, 326, 327, 328, 329, 330, 331, 332, 333, 334, 335, 336, 337, 338, 339, 340, 341, 342, 343, 344, 345, 346, 347, 348, 349, 350, 351, 352, 353, 354, 355, 356, 357, 358, 359, 360, 361, 362, 363, 364, 365, 366, 367, 368, 369, 370, 371, 372, 373, 374, 375, 376, 377, 378, 379, 380, 381, 382, 383, 384, 385, 386, 387, 388, 389, 390, 391, 392, 393, 394, 395, 396, 397, 398, 399, 400, 401, 402, 403, 404, 405, 406, 407, 408, 409, 410, 411, 412, 413, 414, 415, 416, 417, 418, 419, 420, 421, 422, 423, 424, 425, 426, 427, 428, 429, 430, 431, 432, 433, 434, 435, 436, 437, 438, 439, 440, 441, 442, 443, 444, 445, 446, 447, 448, 449, 450, 451, 452, 453, 454, 455, 456, 457, 458, 459, 460, 461, 462, 463, 464, 465, 466, 467, 468, 469, 470, 471, 472, 473, 474, 475, 476, 477, 478, 479, 480, 481, 482, 483, 484, 485, 486, 487, 488, 489, 490, 491, 492, 493, 494, 495, 496, 497, 498, 499, 500, 501, 502, 503, 504, 505, 506, 507, 508, 509, 510, 511, 512, 513, 514, 515, 516, 517, 518, 519, 520, 521, 522, 523, 524, 525, 526, 527, 528, 529, 530, 531, 532, 533, 534, 535, 536, 537, 538, 539, 540, 541, 542, 543, 544, 545, 546, 547, 548, 549, 550, 551, 552, 553, 554, 555, 556, 557, 558, 559, 560, 561, 562, 563, 564, 565, 566, 567, 568, 569, 570, 571, 572, 573, 574, 575, 576, 577, 578, 579, 580, 581, 582, 583, 584, 585, 586, 587, 588, 589, 590, 591, 592, 593, 594, 595, 596, 597, 598, 599, 600, 601, 602, 603, 604, 605, 606, 607, 608, 609, 610, 611, 612, 613, 614, 615, 616, 617, 618, 619, 620, 621, 622, 623, 624, 625, 626, 627, 628, 629, 630, 631, 632, 633, 634, 635, 636, 637, 638, 639, 640, 641, 642, 643, 644, 645, 646, 647, 648, 649, 650, 651, 652, 653, 654, 655, 656, 657, 658, 659, 660, 661, 662, 663, 664, 665, 666, 667, 668, 669, 670, 671, 672, 673, 674, 675, 676, 677, 678, 679, 680, 681, 682, 683, 684, 685, 686, 687, 688, 689, 690, 691, 692, 693, 694, 695, 696, 697, 698, 699, 700, 701, 702, 703, 704, 705, 706, 707, 708, 709, 710, 711, 712, 713, 714, 715, 716, 717, 718, 719, 720, 721, 722, 723, 724, 725, 726, 727, 728, 729, 730, 731, 732, 733, 734, 735, 736, 737, 738, 739, 740, 741, 742, 743, 744, 745, 746, 747, 748, 749, 750, 751, 752, 753, 754, 755, 756, 757, 758, 759, 760, 761, 762, 763, 764, 765, 766, 767, 768, 769, 770, 771, 772, 773, 774, 775, 776, 777, 778, 779, 780, 781, 782, 783, 784, 785, 786, 787, 788, 789, 790, 791, 792, 793, 794, 795, 796, 797, 798, 799, 800, 801, 802, 803, 804, 805, 806, 807, 808, 809, 810, 811, 812, 813, 814, 815, 816, 817, 818, 819, 820, 821, 822, 823, 824, 825, 826, 827, 828, 829, 830, 831, 832, 833, 834, 835, 836, 837, 838, 839, 840, 841, 842, 843, 844, 845, 846, 847, 848, 849, 850, 851, 852, 853, 854, 855, 856, 857, 858, 859, 860, 861, 862, 863, 864, 865, 866, 867, 868, 869, 870, 871, 872, 873, 874, 875, 876, 877, 878, 879, 880, 881, 882, 883, 884, 885, 886, 887, 888, 889, 890, 891, 892, 893, 894, 895, 896, 897, 898, 899, 900, 901, 902, 903, 904, 905, 906, 907, 908, 909, 910, 911, 912, 913, 914, 915, 916, 917, 918, 919, 920, 921, 922, 923, 924, 925, 926, 927, 928, 929, 930, 931, 932, 933, 934, 935, 936, 937, 938, 939, 940, 941, 942, 943, 944, 945, 946, 947, 948, 949, 950, 951, 952, 953, 954, 955, 956, 957, 958, 959, 960, 961, 962, 963, 964, 965, 966, 967, 968, 969, 970, 971, 972, 973, 974, 975, 976, 977, 978, 979, 980, 981, 982, 983, 984, 985, 986, 987, 988, 989, 990, 991, 992, 993, 994, 995, 996, 997, 998, 999, 1000.



representatives of the forms are not found in the following counties: Harding, Luna, Grant, Hidalgo, Dona Ana, Sierra, McKinley, and San Juan. These counties may be divided into three groups. The first group has a sole member, Harding County. There appears to be no reason why the species should not occur here; perhaps a more thorough survey in this area will show the forms to be present.

The second group of counties, Hidalgo, Grant, Luna, Dona Ana, and Sierra, are located in the southwestern portion of the state. While in this area the mean average temperature and soil conditions are agreeable to Ratibida, the average rainfall is not sufficient for survival.

For the third group of counties, San Juan, McKinley, and the western areas of Rio Arriba and Sandoval, another explanation is probable. The environment is favorable for the growth of the species in these areas, but they are not reported there. Apparently mountains form a geographic barrier that serves to isolate this area. At the present time Ratibida appears to be spreading through these mountains and at some future date may expand into this northwestern area.

Ratibida columnifera pulcherrima probably entered New Mexico from the southeast where there are numerous pure populations of the forms. Ratibida columnifera

representatives of the local population, the following countries: Hungary, Poland, Czechoslovakia, and Rumania. The results of the survey are divided into three groups: (1) the first group is the results of the survey, (2) the second group is the results of the survey, and (3) the third group is the results of the survey. The results of the survey are as follows:

The second group of results, which is the results of the survey, is as follows: (1) the results of the survey, (2) the results of the survey, and (3) the results of the survey. The results of the survey are as follows:

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For the second group of results, which is the results of the survey, the results are as follows: (1) the results of the survey, (2) the results of the survey, and (3) the results of the survey. The results of the survey are as follows:



pulcherrima spread in a northeast sweep to the Sacramento Mountains which at the present time have numerous pure populations. Ratibida columnifera pulcherrima has just penetrated west of this range.

The evidence is that R. columnifera columnifera has entered the state from the northeast and the larger pure populations are found here. The western expansion of this variety was limited by the large number of mountain ranges in the northern part of New Mexico which serve as temporary barriers. Ratibida columnifera columnifera spread southward, hybridizing with R. columnifera pulcherrima in the central areas of the state where the two varieties met.

The pure populations seem to follow the contour of the mountain ranges. The populations of R. columnifera columnifera would appear to be running along the north-south canyons because of their southwestern migration through the state. On the other hand, populations of R. columnifera pulcherrima would appear along the east-west canyons since they are apparently migrating toward the northwest area of the state. The region of greatest hybridization in New Mexico is in the Lincoln National Forest. Hybrids appear in greater numbers in the area where the north-south canyons intersect in the east-west canyons. (See the map in fig. 29.)

gibberna spread in a northern sweep to the  
Saskatchewan mountains which at the present time have  
numerous gibberna. gibberna gibberna  
gibberna has just penetrated west of this range.  
The evidence is that gibberna gibberna  
has entered the state from the northwest and the former  
pure populations are found here. The western expansion  
of this variety was limited by the large number of  
mountain ranges in the northern part of the state which  
serve as temporary barriers. gibberna gibberna  
gibberna spread southward, hybridizing with gibberna  
gibberna gibberna in the central part of the state  
where the two varieties met.  
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gibberna gibberna would appear to be rather  
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tions of gibberna gibberna and gibberna gibberna  
the east-west canyon area they are generally migra-  
ting toward the northwest area of the state. The  
of greatest hybridization in the state is in the  
Lincoln National Forest. Hybridization is greatest  
however in the area where the north-west canyon basin  
meet in the east-west canyon. (See also page 17, 18.)



Pollen fertility was determined for the parents and putative hybrids, and the results are recorded in Table I. The conclusion that may be drawn from the results of this table is apparent. There is no significant loss of fertility in the purple-yellow hybrid plants when compared with the parental R. columnifera columnifera and R. columnifera pulcherrima.

Morphological differences between the two entities appear to be lacking. They can, however, be separated on the basis of ligule color. Ratibida columnifera columnifera has yellow ligules while in R. columnifera pulcherrima the ligules are purple. According to Morrow (1927, p. 325), anthocyanin pigments produce the purple color in the ligules. Upon standing, anthocyanin pigments break down in a neutral alcohol solution and, therefore, lose their color by conversion to the colorless isomer. With the addition of dilute acids, the anthocyanin can be stabilized in the form of the colored isomer. The yellow pigment is produced by the presence of xanthophylls. This pigment is an intra-cellular glucoside, which was found to be only slightly soluble in an alcoholic or aqueous solution. Xanthophylls were found to be of maximum color intensity and most soluble in an acid environment. It can be noted that the index of absorption and the ratio of the two pigments are directly proportional (see fig. 30). This would seem to

Pollen fertility was determined for the parents and putative hybrids, and the results are recorded in Table I. The conclusion that may be drawn from the results of this table is apparent. There is no significant loss of fertility in the purple-yellow hybrid plants when compared with the parental *H. columbiana* and *H. columbiana* palohensis.

Morphological differences between the two entities appear to be lacking. They can, however, be separated on the basis of ligule color. *Latidid columbiana* has yellow ligules while in *H. columbiana* palohensis the ligules are purple. According to Kew (1937, p. 525), anthocyanin pigments produce the purple color in the ligules. Upon standing, anthocyanin pigments break down in a neutral alcohol solution and, therefore, lose their color by conversion to the colorless isomer. With the addition of dilute acids, the anthocyanin can be stabilized in the form of the colored isomer. The yellow pigment is produced by the presence of xanthophylls. This pigment is an intra-cellular glucoside, which was found to be only slightly soluble in an alcoholic or aqueous solution. Xanthophylls were found to be of maximum color intensity and most soluble in an acid environment. It can be noted that the index of absorption and the ratio of the two pigments are directly proportional (see fig. 50). This would seem to



indicate that the colors are inherited quantitatively.

The color of the natural hybrids studied here can best be explained by the multiple factor hypothesis. There is an absence of sharp, easily definable classes of hybrid types. The absence of distinct groups is the chief characteristic of quantitative inheritance (Sinnott et al., 1950, p. 122).

Representative patterns can be used as a basis for arbitrarily classifying color variation of the ligules of R. columnifera columnifera, R. columnifera pulcherrima, and their hybrids. The following Table II may be utilized for this purpose.

In Rudbeckia, which is closely related to Ratibida, Blakeslee found (fide Sinnott et al., 1950, p. 105) a chemical method of distinguishing genetic types of yellow cones of Rudbeckia hirta. In Rudbeckia hirta the yellow in the cones evidently results from chemically different processes than does the purple in the cones. The hybrids resulting from a cross between one type of yellow cone plant with another were purple. Therefore hybrids carried the reaction to a further stage (purple) than was possible by the parent possessing only one factor. Cases of interaction such as this, in which two genes are similar in individual effects but produce a totally new effect when together, are caused





by complementary genes. These genes may be modified by the genotype in which they appear. Such a situation may be responsible for some of the variation in the hybrid swarms of Ratibida. For example, sample numbers one and two (fig. 30) appear to possess more pigment than the parent R. columnifera pulcherrima.

The main purpose of this study was to obtain additional data concerning the taxonomic status of R. columnifera pulcherrima and R. columnifera columnifera. The two taxa occupy different ranges in New Mexico. However, highly variable natural populations consisting of parents and hybrid swarms occur where the geographic boundaries of the taxa overlap. Anderson (1952, p. 101) found much the same situation in Tradescantia and the domesticated avocado. So long as diverging taxa are able to hybridize naturally and merge back into a single population, they are not reproductively isolated, hence are not independent species. Varieties, like species, may carry different gene complexes which best fit them to survive in their different habitats. Ratibida columnifera columnifera and R. columnifera pulcherrima show different habitat preferences. Genetic differences also manifest themselves in color differences; hence there is justification for characterizing them as forms by visible external characteristics. The writer





therefore believes that R. columnifera columnifera and  
R. columnifera pulcherrima are valid varieties.

REPORTER'S NAME: E. J. [illegible]  
B. [illegible] [illegible] [illegible]

NOTICE  
EXERASE  
MILERS FALLS



Table I. Fertility of Parental Species and Putative Hybrids

Accession no.	Ligule color	Percentage of stainable pollen
R3x1	mixed	95
R1x15	mixed	96
R3x2	mixed	96
R2x17	purple	96
R2x4	purple	97
R1x2	yellow	95
R6x10	yellow	96

# F E B W S E

## M I T T E R S F A L L S

Table 1. Summary of results of the study of the effect of the treatment of the water on the growth of the fish.

Treatment of water	No. of fish	Growth (mm)
Control	10	12.5
Aerated	10	15.0
Filtrated	10	14.0
Boiled	10	13.0
Oxidized	10	16.0
Chlorinated	10	17.0
Irradiated	10	18.0



Figure 29

Distribution of Ratibida columnifera columnifera,  
Ratibida columnifera pulcherrima, and their hybrids  
in the Lincoln National Forest

## Key

- o R. columnifera columnifera
- R. columnifera pulcherrima
- x Hybrids

221BVE

Classification of Excluded Persons  
Excluded Persons Excluded Persons  
in the United States

Key

- o Excluded Persons
- e Excluded Persons
- x Excluded Persons



# LINCOLN NATIONAL FOREST REGION

NEW MEXICO

SCALE OF MILES

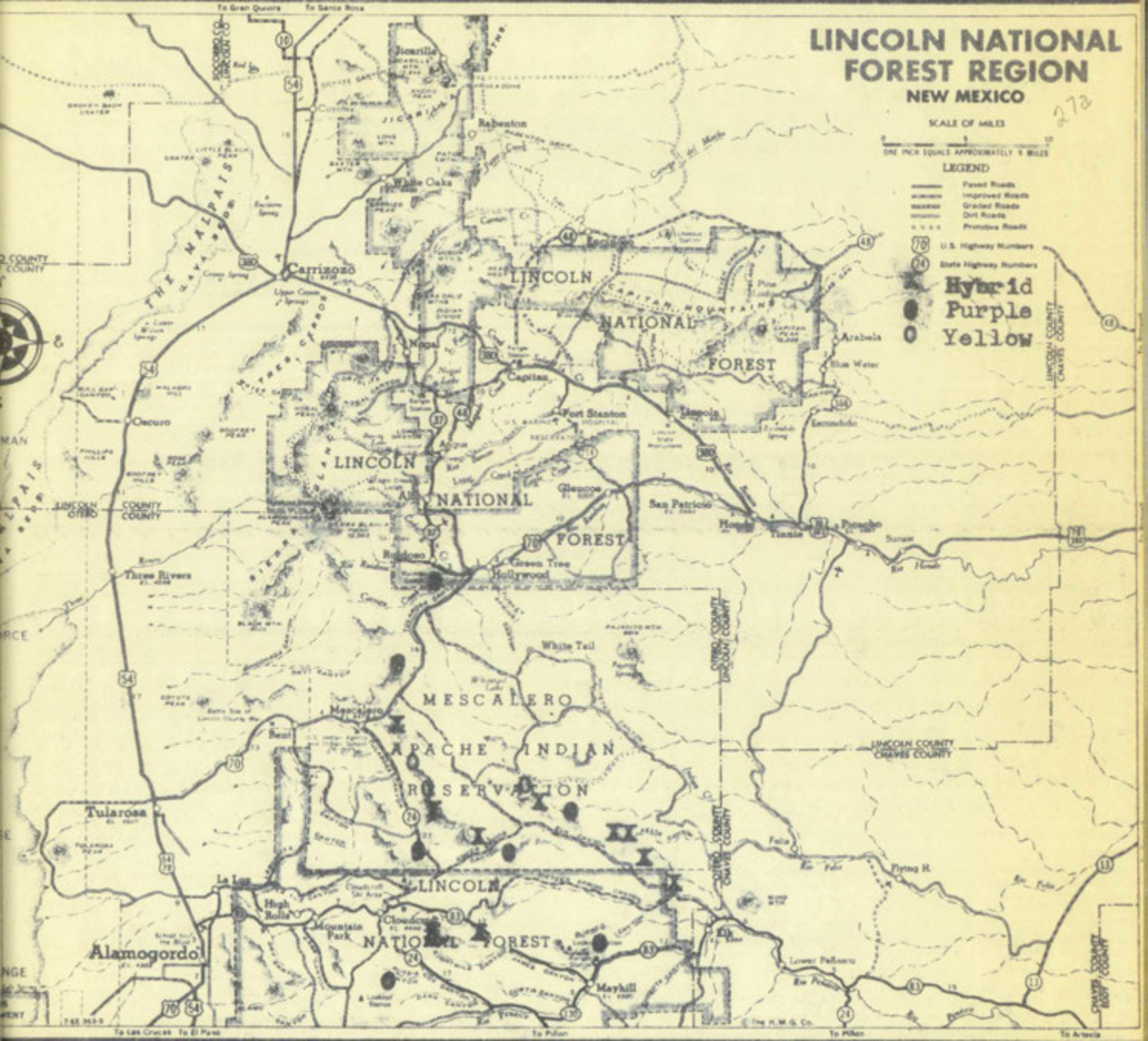
ONE INCH EQUALS APPROXIMATELY 9 MILES

## LEGEND

Forest Roads  
 Improved Roads  
 Graded Roads  
 Dirt Roads  
 Primitive Roads

U.S. Highway Numbers  
 State Highway Numbers

Hybrid  
 Purple  
 Yellow



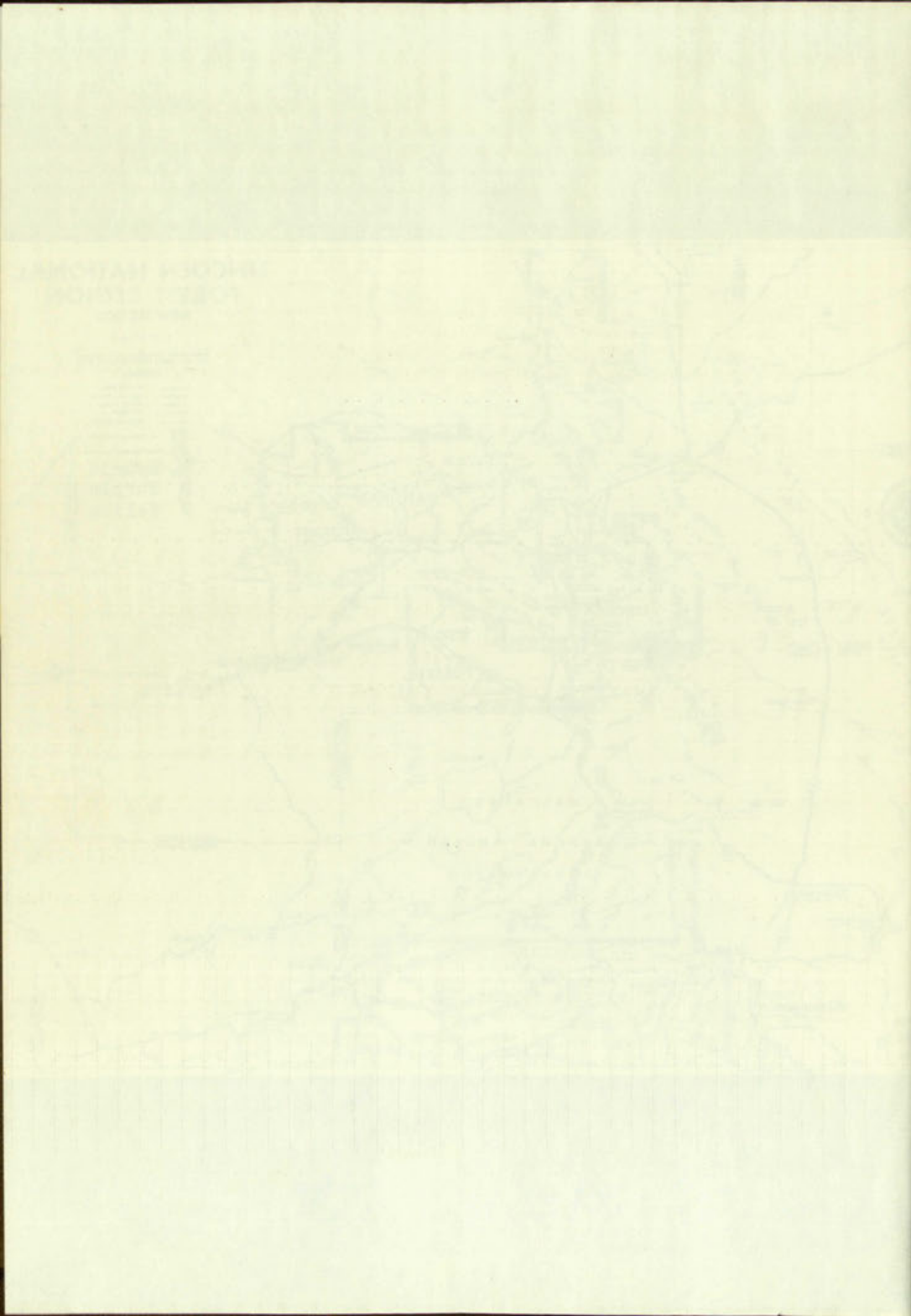




Table II. Classification of ligules of Ratibida columnifera columnifera, Ratibida columnifera pulcherrima, and their hybrids according to color patterns

Classes	Color Ratio
I	100% yellow
II	25% purple; 75% yellow
III	50% purple; 50% yellow
IV	75% purple; 25% yellow
V	100% purple

Table II. Classification of types of cotton  
gins and their relative efficiency  
in cleaning cotton  
by the use of the

Class	Order
I	Lowest
II	Low
III	Medium
IV	High
V	Highest

EZERA  
 MILITARY



## Figure 30

Graphic relationship of the hybrids to the parental  
types with regard to relative quantities of purple  
and yellow pigments: 10 yellow, 11 purple,  
and 70 putative hybrids

1917

Graphic design is a branch of the visual arts that  
uses visual elements to create a message or convey information.  
It is a form of communication that is both artistic and functional.  
The design process involves the selection and arrangement of visual  
elements to create a cohesive and effective composition.

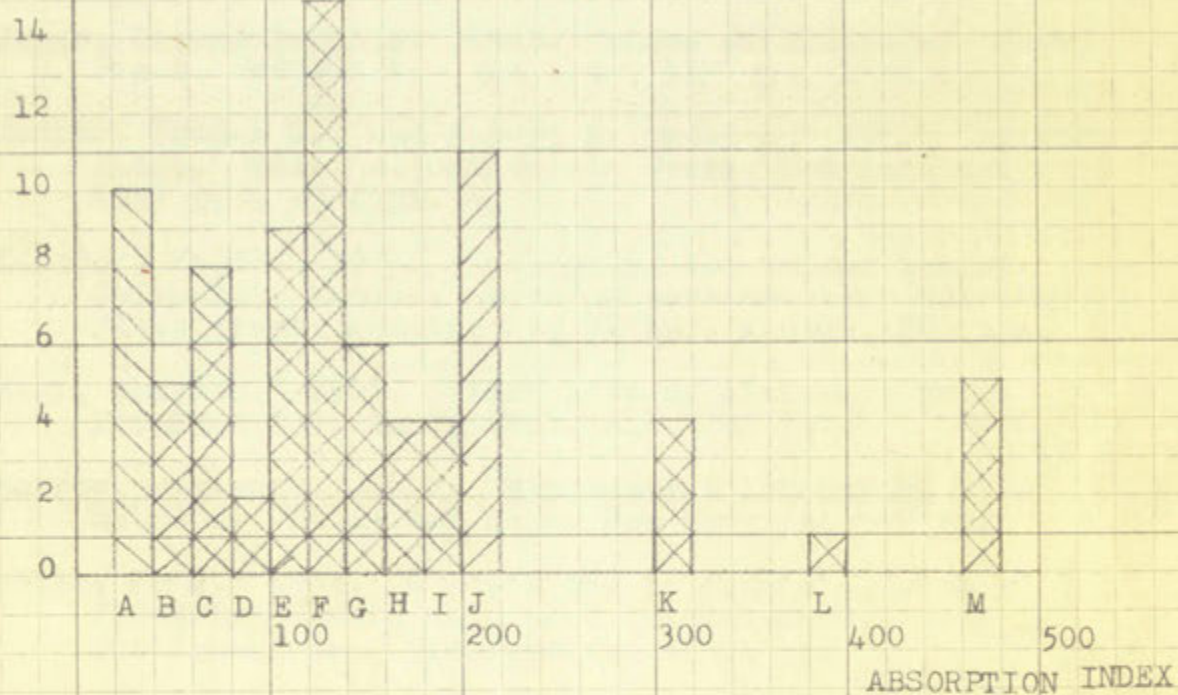
THE  
FRENCH  
CIVIL  
SERVICE



FREQUENCY

KEY

A		pure yellow parental type
B-D		hybrids type 1
E-G		hybrids type 2
H-I		hybrids type 3
J		pure purple parental type
K-M		hybrids type 3



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UNIVERSITY OF NEW MEXICO  
DEPARTMENT OF GEOLOGY



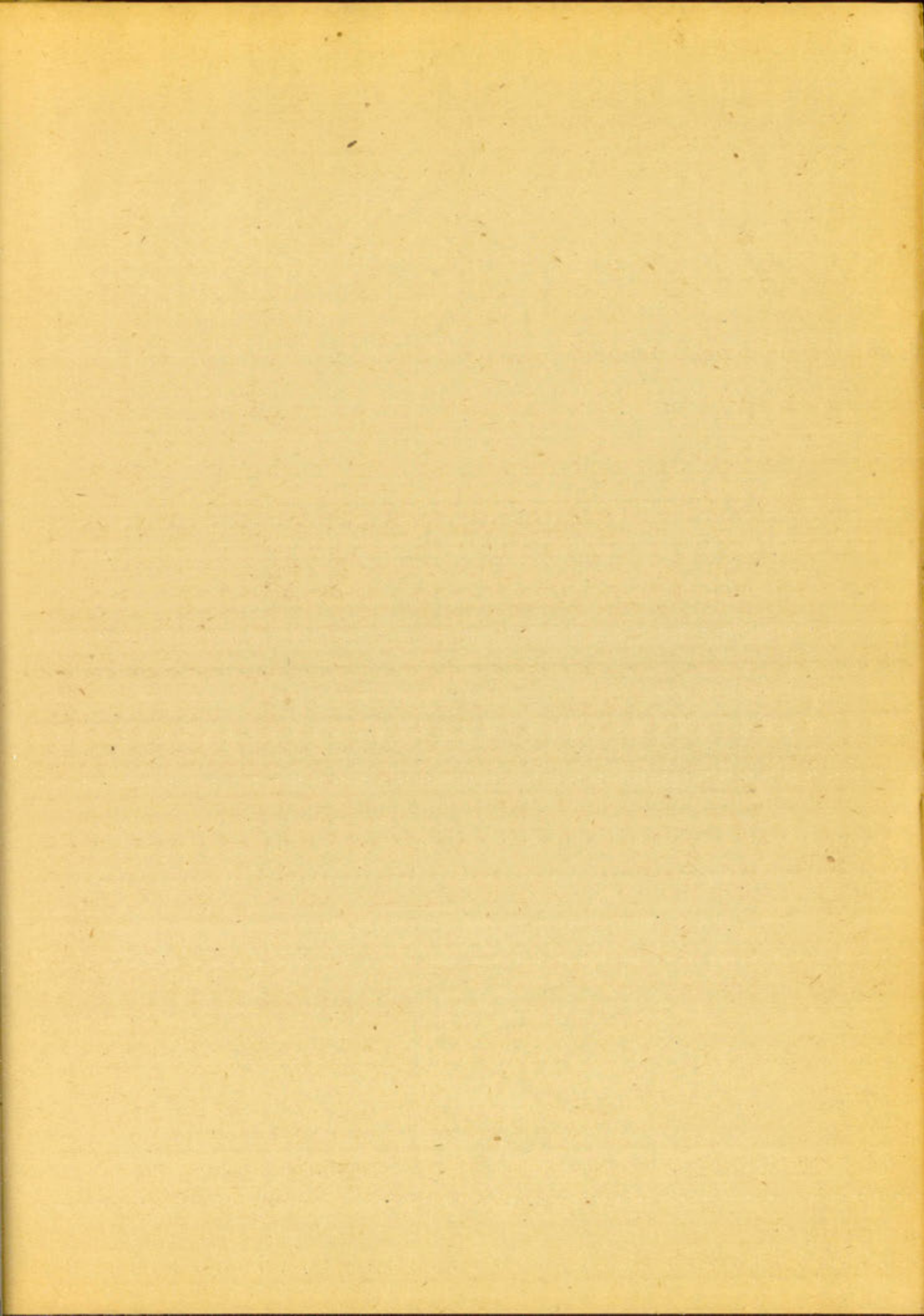
COTTON CONTENT

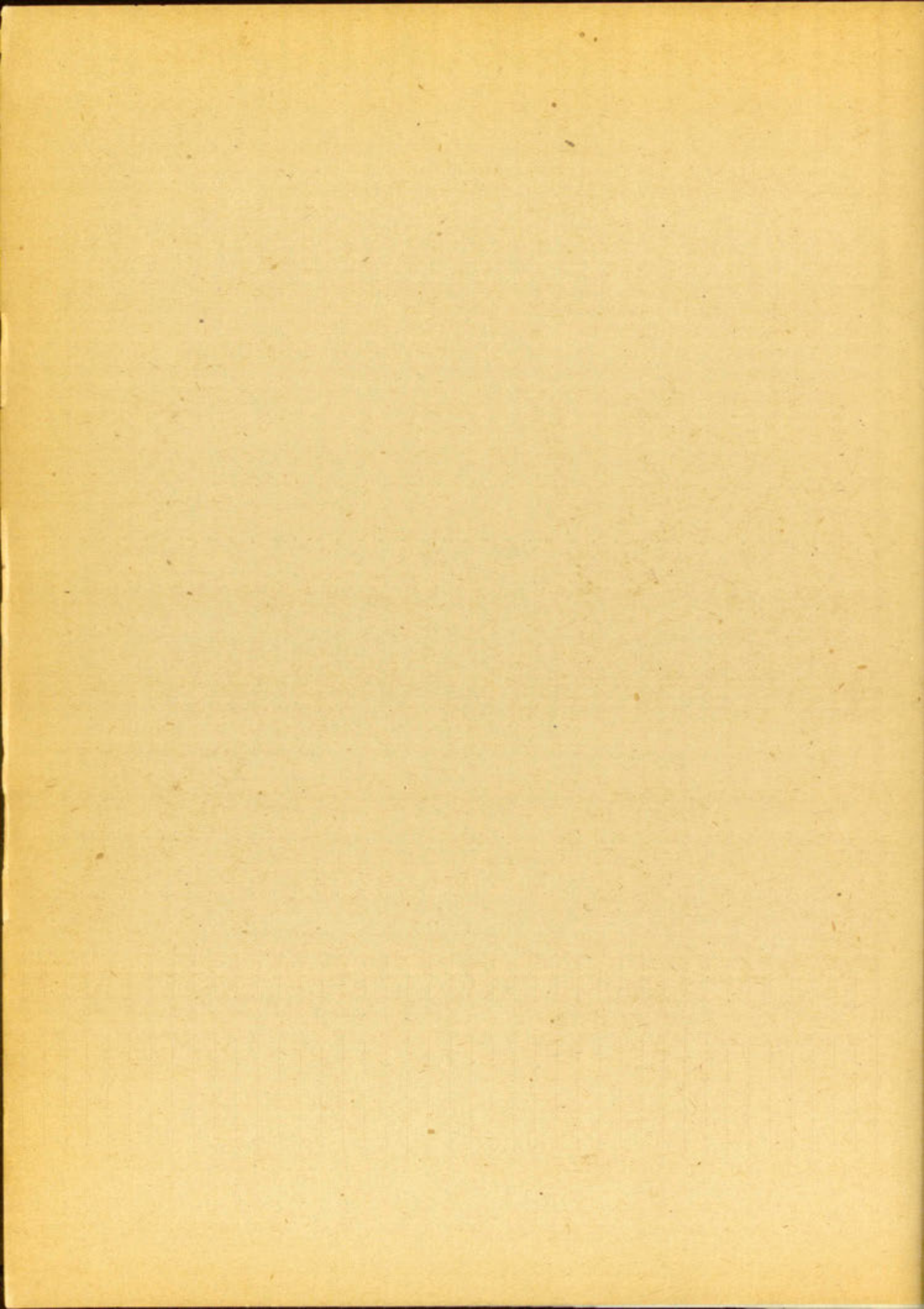
RESERVE

WITNESS PARTS

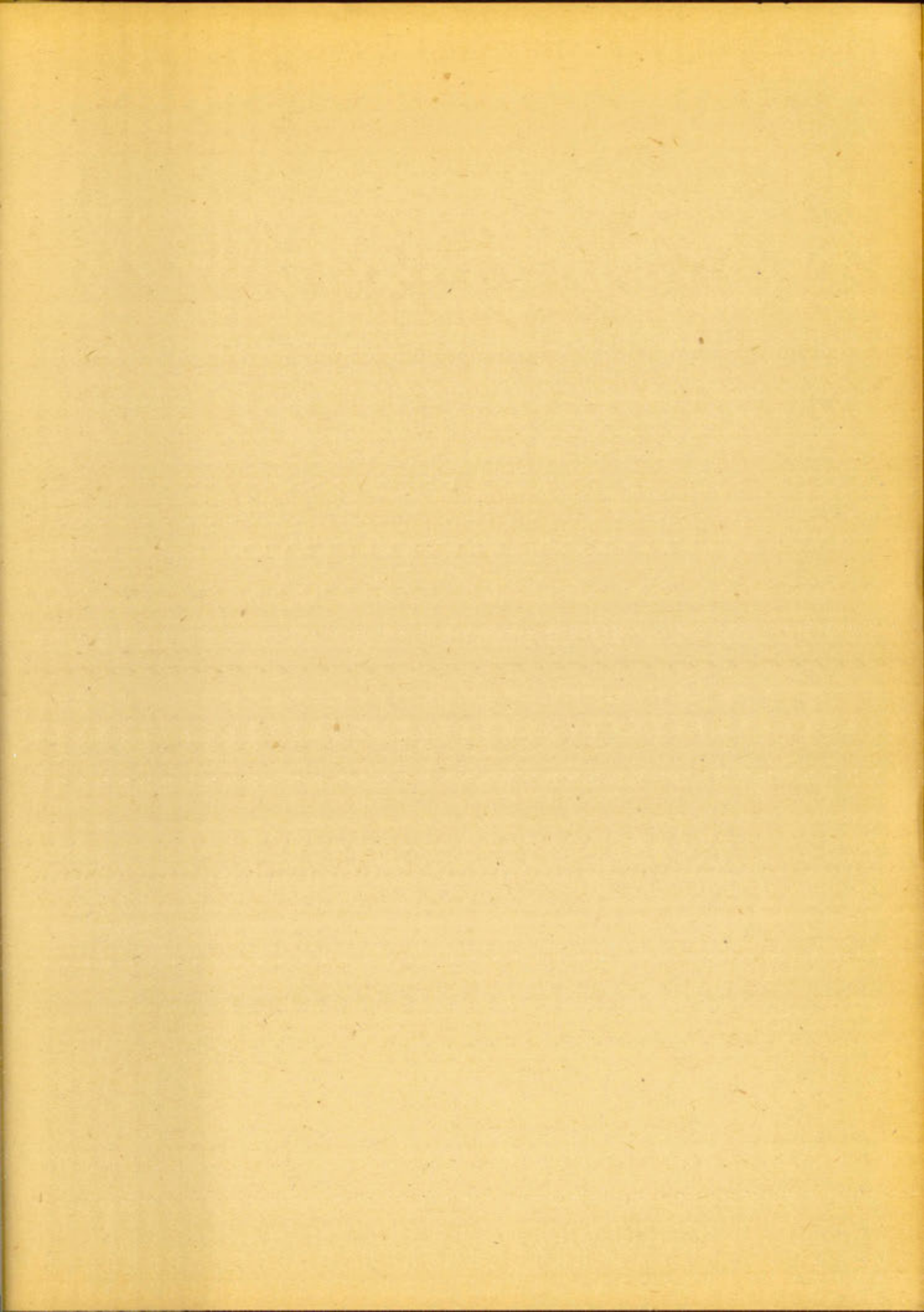
MILLERS FALLS  
EZEKIEL  
COTTON CONTENT

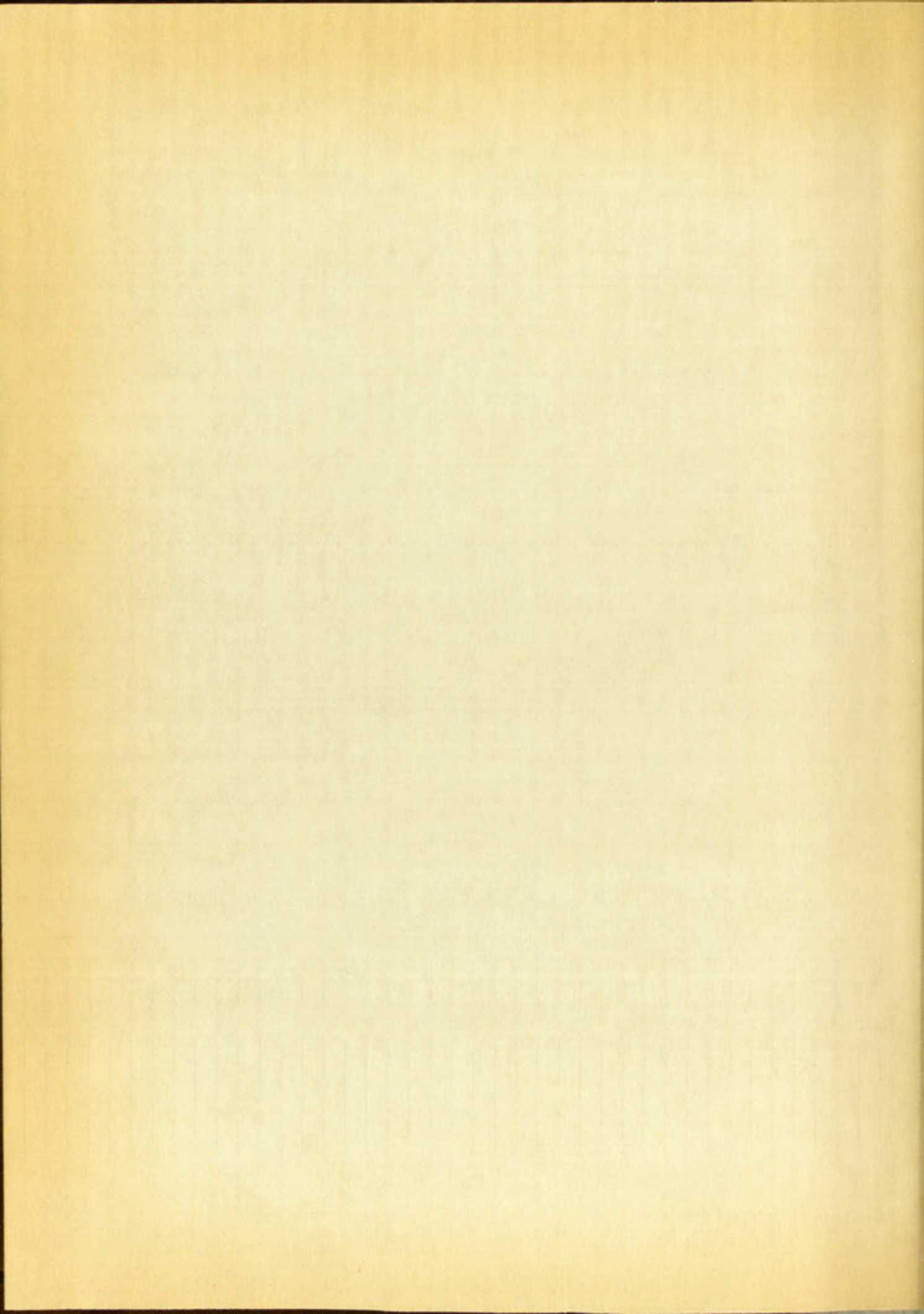




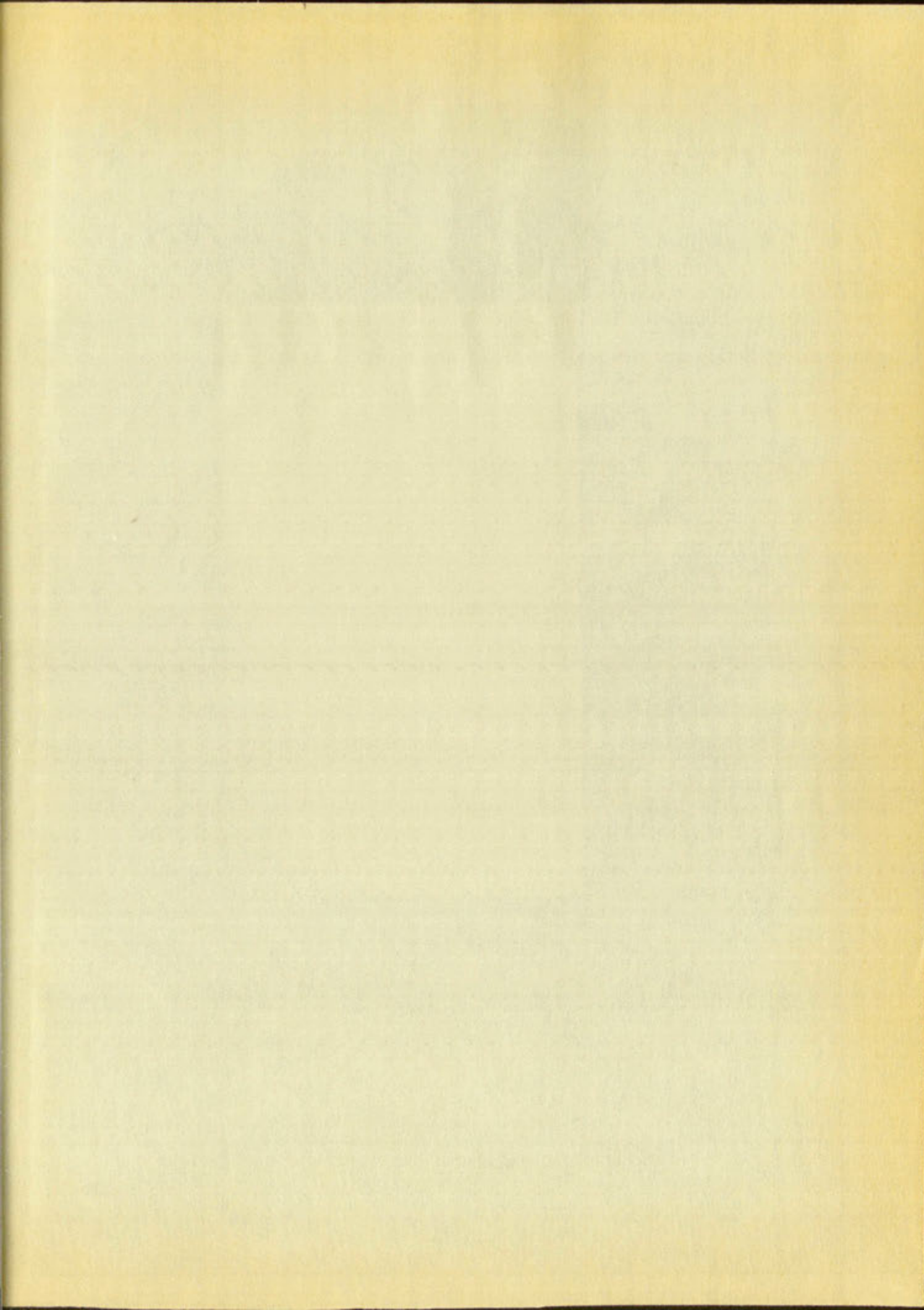













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