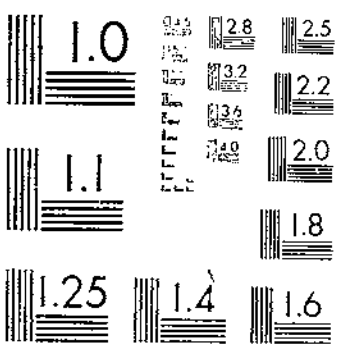
TB-684 (1938) USDA TECHNICAL BULLETINS UPDATA

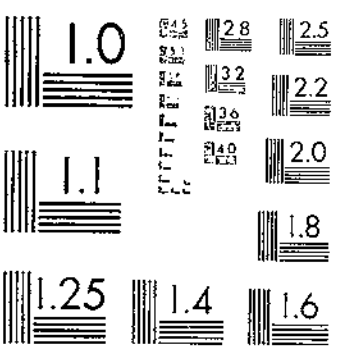
RUBBER CONTENT AND HABITS OF A SECOND DESERT MILKWEED (ASCLEPIAS EROSA)

BECKETT, R.E., STITT, R.S., DUNCAN, E.N. 1 OF 1

START



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS 1963 A



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS 1963 A

Technical Bulletin No. 604 February 1938

UNITED STATES DEPARTMENT OF AGRICULTURE
WASHINGTON, D. C.

RUBBER CONTENT AND HABITS OF A SECOND DESERT MILKWEED (ASCLEPIAS EROSA) OF SOUTHERN CALIFORNIA AND ARIZONA[1]

By R. E. Beckett, *principal scientific aide*, R. S. Stutt, formerly *assistant scientific aide*, and E. N. Duncan, *assistant scientific aide, Division of Plant Exploration and Introduction, Bureau of Plant Industry*

CONTENTS

INTRODUCTION

Many species of native rubber-producing plants in the United States have been investigated, including several milkweeds of the genus *Asclepias* (*1, 2, 3, 6, 9, 10*).[2] Hall and Long (*6*) were the only investigators who referred to the rubber content of *Asclepias erosa* Torr. Their investigations of this species were not very extensive, and the highest percentage of rubber obtained was 2.5, in the leaves of a plant collected near Tehachapi, Calif. Investigations conducted from 1931 to 1934 at the United States Acclimatization Garden, near Bard, Calif., showed that the leaves of the wild plants of *A. erosa* growing in Yuma County, Ariz., have a rubber content ranging from 2.45 to 13.06 percent; also that 1-year-old progenies selected from high-yielding plants produced from 4.55 to 11.53 percent of rubber.

Various experiments on habits of growth, rubber content, and cultural characters of *Asclepias erosa* were begun in 1931; however, they were not completed because this phase of the activities of the Bureau of Plant Industry at Bard was discontinued in 1934. Since it appeared that the data already obtained might be of value to other investigators, the available results are offered here.

[1] Submitted for publication Aug. 26, 1937.
[2] Italic numbers in parentheses refer to Literature Cited, p. 11.

PLANT CHARACTERS AND NATURAL DISTRIBUTION

Asclepias erosa is a perennial herb with stout upright stems 3 to 4 feet high and sometimes 6 feet. The stems are numerous, 8 to 20 per plant, and sparsely branched. The leaves occur in opposite pairs, nearly sessile, ovate, lanceolate, pubescent when young, but practically glabrous when mature. The mature leaves are 6 to 8.5 inches long, and 2.5 to 3.5 inches wide at the base, very abundant and persistent, the first leaves usually being retained until autumn (fig. 1). The flowers are pale cream or greenish and are borne in umbels at the end of the shoots. The seed pods are 2.5 to 3 inches long and 1.5 to 1.75 inches wide; they split along one side when ripe, which permits the seeds to be scattered by the wind. The seeds are flat, about one-half inch long and three-eighths inch wide, with a pappus of silky hairs attached at the hilum. Floral buds, seed pods, and seeds are shown in figure 2. A more detailed description of *A. erosa* was published by Gray (*4, p. 94*).

The natural distribution of *Asclepias erosa* is limited to the arid regions of the Southwest. It is known to extend from Kern to Inyo Counties in California, south through the Mohave Desert to San Diego County, east to north-central Sonora, Mexico, and north to Utah.

The plants observed by the writers have been confined to dry gravelly stream beds, where the water runs for short periods after infrequent rains, and to the borrow pits along highways and railways. They usually are found in scattered groups of 10 or more. In one locality between Parker and Bouse, Ariz., there are several groups of 70 or 80 plants each, occurring in intermittent groups along the washes for a distance of 2 or 3 miles on either side of the highway.

COLLECTION AND PREPARATION OF MATERIAL AND EXTRACTION OF RUBBER

The rubber determinations were made on plants collected in the vicinity of Parker and Wellton, Yuma County, Ariz., and from plants grown at the United States Acclimatization Garden, near Bard, Calif., from seeds collected near Parker.

Samples collected in the autumn consisted of entire plants cut off within a few inches of the ground. After the data on the height, number of stems, and condition of growth were recorded, the plants were wrapped separately in paper and stored in a dry room. When they had dried sufficiently the leaves were removed, and the weights of the leaves and stems were recorded separately. The dry stems were then cut into sections about a quarter of an inch long and then ground in a hand mill until the material would pass through a 20-mesh sieve. The leaves were crushed by hand and then ground, as described. A 4-gram sample of the ground material was taken for analysis. The material collected during the growing season consisted of leaves from various parts of the plants. These leaf samples were dried and handled as described above.

The rubber was extracted by the same method used by Hall and Long (*6*), namely, with the Bailey-Walker apparatus. The ground material was treated for 3 hours with acetone to remove chlorophyll, fats, and resins, and then treated with benzol for 3 hours to remove the rubber. Samples of material were analyzed in duplicate, and the results are the mean of the two determinations.

FIGURE 1.—*A*, Group of *Asclepias erosa* plants as they appear in their natural habitat, near Parker, Ariz.; *B*, an individual plant from the above group.

FIGURE 2.—Floral buds, flowers, seed pods, and seeds of *Asclepias eroса*. (Natural size.)

RUBBER CONTENT OF WILD PLANTS

Analyses made in 1931 on wild plants collected near Wellton showed the ranges in rubber content recorded in table 1, wherein are also given the plant height, number of stems per plant, dry-plant weight, and percentage of dry-plant weight represented by the leaves. It was found that the leaves represented over 50 percent of the dry weight of the plants and contained about 90 percent of the rubber.

The rubber content of the individual plants from the two localities varied considerably. Of the Parker group, 73 percent of the plants analyzed had a rubber content greater than that of the highest-yielding plant from the Wellton group, as shown in table 2. Some of the variation in the rubber content of the individual plants probably was due to the seasonal and environmental conditions, but a large part no doubt was due to the different strains in the two localities. Progeny selections of the Parker group, grown at the acclimatization garden, showed the same high rubber-yielding tendency as was shown by the parent plants.

TABLE 1.—*Mean height, number of stems, dry-plant weight, leaf percentage of dry-plant weight, and rubber content of leaves and stems of Asclepias erosa plants collected near Wellton and Parker, Ariz., 1931–33*

Locality and year collected and analyzed	Plants	Mean height	Stems per plant		Dry-plant weight		Leaf percentage of dry-plant weight		Rubber in—			
									Leaves		Stems	
			Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean
	No.	*In.*	*No.*	*No.*	*Grams*	*Grams*			*Pct.*	*Pct.*	*Pct.*	*Pct.*
Wellton, 1931	10				80–219	138	46–68	56.5	2.45–7.53	4.57	0.29–0.81	0.43
Parker:												
1932	10	42.7	5–12	8	77–181	122	29–62	51.5	6.32–12.77	9.15	.38–.65	.49
1933	30	40.7	1–10	4	38–509	190	34–77	53.7	6.43–13.06	9.71		

TABLE 2.—*Frequency distribution and mean percentage of rubber of the leaves of Asclepias erosa collected near Wellton and Parker, Ariz., 1931–33*

Location and year analyzed	Plants showing rubber content of—												Mean
	2.00 to 3.00 percent	3.01 to 4.00 percent	4.01 to 5.00 percent	5.01 to 6.00 percent	6.01 to 7.00 percent	7.01 to 8.00 percent	8.01 to 9.00 percent	9.01 to 10.00 percent	10.01 to 11.00 percent	11.01 to 12.00 percent	12.01 to 13.00 percent	13.01 to 14.00 percent	
	No.	*No.*	*No.*	*No.*	*No.*	*No.*	*No.*	*No.*	*No.*	*No.*	*No.*	*No.*	*Pct.*
Wellton, 1931	3	2	1	2	0	2	0	0	0	0	0	0	4.57
Parker:													
1932	0	0	0	0	2	2	0	2	2	0	2	0	9.15
1933	0	0	0	0	1	6	1	10	5	4	2	1	9.71

SEASONAL GROWTH AND RUBBER CONTENT

In order to ascertain the rate of plant growth and the increase in rubber content during the season, the height, number of stems, and rubber content were determined on each of 10 plants growing near Parker in October 1932, and again in June and October 1933.

The plants were still green when harvested in October 1932, but they were fully mature and a few of the lower leaves had begun to

turn yellow. At this date the plants averaged 42.7 inches in height, and had an average of eight stems per plant. Plants in this group were killed to the ground by frost about the middle of November.

The first observations in 1933 were made early in April, after the plants had started to grow, and had from two to eight young stems 8 to 12 inches high. Measurements of the height and number of stems and leaf samples for rubber determinations were made on June 7. Four of the plants under observation and many others in the group were partly or completely defoliated by caterpillars (*Eupseudosoma involutum* Sepp.) (fig. 3). Although these plants recovered

FIGURE 3.—*Asclepias erosa* plant near Parker, Ariz., defoliated by the caterpillars (*Eupseudosoma involutum* Sepp.). Photographed June 7, 1933.

before the season was over, it was necessary to drop them from the study. On June 7 the mean height of the remaining six plants was 37.7 inches, with a mean of 8.3 stems per plant (table 3). All of the plants were flowering freely, and a few pods were developing.

Similar measurements recorded in October 1933 showed that the plants had grown very little in height and had only a few more stems than they had in June, but that several branches had been produced on the upper part of the stems. The mean height of the plants at this date was 42.2 inches, with a mean of 9.5 stems per plant.

TABLE 3.—*Height of plants, number of stems, and rubber content of 6 Asclepias erosa plants collected near Parker, Ariz., in October 1932 and in June and October 1933*

Plant no.	October 1932			June 1933			October 1933		
	Height	Stems per plant	Rubber content	Height	Stems per plant	Rubber content	Height	Stems per plant	Rubber content
	Inches	*Number*	*Percent*	*Inches*	*Number*	*Percent*	*Inches*	*Number*	*Percent*
1	45	9	9.00	48	10	2.50	50	11	9.46
2	49	6	10.49	42	8	3.02	48	9	9.89
3	35	8	12.04	36	9	2.84	40	14	11.93
8	36	9	7.32	24	8	2.22	33	8	7.48
9	45	12	6.32	28	12	4.57	34	14	6.21
10	46	5	12.55	48	3	3.41	48	4	12.09
Mean	42.7	8	9.62	37.7	8.3	3.14	42.2	9.5	9.51

In June 1933 the mean rubber content of the plants was approximately one-third what it was in October 1932 and in October 1933, the mean rubber content being about the same on the two latter dates. Although rubber determinations were made at only one period during the growing season, it is assumed, from data obtained on other milkweeds, that the rubber content gradually increased as the season advanced and reached the maximum when the plants matured in the autumn.

RUBBER CONTENT OF STORED LEAVES

Since *Asclepias erosa* is a herbaceous perennial, with the plants drying up and shedding their leaves soon after reaching maturity, the period for harvesting is limited. A series of experiments was begun with the leaves of seven plants harvested in October 1932 to determine the length of time harvested material could be stored without affecting the rubber content.

After the harvested plant material had dried sufficiently, the leaves were removed, ground, put into brown manila paper bags, and stored in a dry room under normal light conditions. Representative samples were drawn for rubber determinations in October 1932, June 1933, and April 1934. The results of these analyses are shown in table 4, and indicate that under normal light conditions the leaves of *Asclepias erosa* may be stored for a period of at least 18 to 20 months without appreciable loss in rubber content.

TABLE 4.—*Rubber content of stored leaves of 7 plants of Asclepias erosa analyzed when harvested in October 1932, and after storage in June 1933 and April 1934*

Plant No.	Rubber content			Plant No.	Rubber content		
	When harvested in October 1932	After storage to			When harvested in October 1932	After storage to	
		June 1933	April 1934			June 1933	April 1934
	Percent	*Percent*	*Percent*		*Percent*	*Percent*	*Percent*
1	9.09	8.11	9.01	6	9.50	8.88	9.28
2	10.49	9.79	10.06	7	7.17	7.69	6.98
3	12.04	11.37	11.75				
4	6.37	6.47	6.63	Mean	9.34	8.96	9.20
5	10.82	10.13	10.67				

PROPAGATION AND CULTURE

The seeds of *Asclepias erosa* germinate readily and, therefore, no attempt was made to propagate the plants vegetatively. Nine large plants, however, were successfully transplanted from their native habitat, near Parker, to the acclimatization garden. These plants were transplanted in March, while dormant, and the old growth was pruned off within a few inches of the root crown. The roots were pruned, and the entire plant was wrapped in wet sacks while being moved. The plants were irrigated when they were set out, also about every 7 days for the first 3 weeks, and approximately once a month thereafter during the growing season. Six of the plants produced new growth, in April, five of which continued to grow and developed into fairly large healthy plants, and the sixth died in the early summer. The remaining three plants did not survive transplanting.

Two hundred seeds were planted in September 1932 in small tar-paper pots filled with native sandy soil. The pots were sprinkled daily for the first 2 weeks and, at the end of that period, 89 percent of the seeds had germinated. Thereafter the seedlings were watered when necessary. On April 11, 1933, the seedlings were 6 to 8 inches high and were transplanted to a field of sandy loam. These seedlings were irrigated in the manner described for the transplanted native plants, and the mortality was negligible.

Seeds collected from four plants near Parker in the autumn of 1932 were planted by hand on April 11, 1933, in hills 3 by 3 feet in a pre-irrigated seedbed. The field was irrigated twice during the first 3 weeks after planting, and at about monthly intervals thereafter, and cultivated as needed to control weed growth. The four selections showed the following percentages of germination 20 days after planting: 19.4, 39.7, 60.8, and 82.4. The low percentage of two of the selections probably was due to the seeds being collected from late-season pods, as later tests showed that the viability of such seeds was very low.

The seedlings made rapid growth and, by June 5, 55 days after planting, they averaged 4.2 inches in height, with three pairs of leaves averaging 3.5 inches in length and 1 inch in width at the base. Many of the seedlings produced flowers early in September and mature pods in late October. Data recorded November 1 are shown in table 5.

TABLE 5.—*Mean height, number of stems, dry-plant weight, and percentage of dry-plant weight represented by leaves of Asclepias erosa plants planted in April 1933*

[Data recorded November 1933]

Selection No.	Plants	Mean height	Mean number of stems	Mean dry weight of plants	Dry weight represented by leaves
	Number	*Inches*		*Grams*	*Percent*
1	23	14.1	1.6	33.5	75.6
3	12	15.7	2.0	36.1	72.7
9	14	19.5	1.1	35.1	74.7
10	33	13.6	2.6	30.0	77.2
A[1]	16	12.6	2.3		
Mean		14.8	1.8	36.2	75.0

[1] Planted in tar-paper pots in September 1932 and transplanted to field April 1933.

No advantage was gained by planting the seeds in tar-paper pots in a hotbed and later transplanting the seedlings to the field. At the end of the growing season the plants thus transplanted were no larger

than the plants from seed planted directly in the field on April 11, 1933, the same date the seedlings were transplanted from the pots. Moreover, the increase in germination was not great enough to justify the time and labor involved.

SELECTION FOR RUBBER-YIELDING CAPACITY

Experiments were begun in 1933 to determine the possibility of establishing high rubber-yielding strains by selection, to obtain data on the inheritance of rubber-yielding capacity, and to determine the length of time required for the plants to reach their maximum rubber content.

Seeds were collected from four plants in the Parker group which had been analyzed for rubber content. Selection 9 had a low, selection 1 a medium, and selections 3 and 10 a high rubber content, as shown in table 6. Seeds of these selections were planted at the acclimatization garden in April 1933, and in November all of the progeny plants of suitable size were harvested and the rubber content of the leaves determined. Table 6 shows these analyses, also the mean rubber content of the progenies and of the parent plants.

Five of the progenies of selection 1 had a higher percentage of rubber than the parent plant, but the mean was 1.5 percent less. Of the 14 progenies of selection 9 analyzed, 9 had a higher percentage of rubber than the parent plant, and the mean for the progenies was slightly higher. While none of the progenies of selections 3 and 10 attained the rubber content of the parent plants, there were a few in each strain that showed the high-yielding tendency of the parents.

The mean rubber content of the 1-year-old progenies ranged from 64 to 103 percent of that of the matured parent plants. From this study of the 1-year-old progenies, there is an indication that full rubber-yielding capacity is reached early in the life of the plants; however, such a study should be conducted for a period of years to obtain conclusive results.

TABLE 6.—*Frequency distribution and mean percentage of rubber of 1-year-old Asclepias erosa seedlings and percentage of rubber of parent plants*

Selection No.	Progenies of each selection showing rubber content of—														Mean	Percentage of rubber of parent plants
	4.50 to 5.00 percent	5.01 to 5.50 percent	5.51 to 6.00 percent	6.01 to 6.50 percent	6.51 to 7.00 percent	7.01 to 7.50 percent	7.51 to 8.00 percent	8.01 to 8.50 percent	8.51 to 9.00 percent	9.01 to 9.50 percent	9.51 to 10.00 percent	10.01 to 10.50 percent	10.51 to 11.00 percent	11.01 to 11.50 percent	11.51 to 12.00 percent	
	No.	*No.*	*No.*	*No.*	*No.*	*No.*	*No.*	*No.*	*No.*	*No.*	*No.*	*No.*	*No.*	*No.*	*No.*	*Pct.*	
1	1	2	1	3	2	1	0	1	1	1	3	1	0	0	0	7.50	9.09
3	0	3	1	2	3	1	2	0	1	0	0	0	1	1	0	7.73	12.04
9	0	1	2	4	4	2	1	0	0	0	0	0	0	0	0	6.52	6.32
10	1	4	0	0	5	1	5	2	2	5	1	1	1	1	1	8.18	12.55

COMPARISON OF RUBBER CONTENT IN ASCLEPIAS EROSA WITH VARIOUS MILKWEEDS AND OTHER PLANTS

A comparison of the rubber content of the various species of *Asclepias* given in table 7 shows that the highest content of rubber

recorded for individual plants was for *A. erosa*, *A. sullivantii*, *A. subulata*, and *A. galioides*. The mean rubber content of 8.57 percent for all plants of *A. erosa* analyzed was higher than that recorded for any individual plant of the other species.

The rubber content of plants of *A. erosa* compares favorably with that of other native plants and some species of *Cryptostegia*. Hall and Goodspeed (5) reported a rubber content of 6.57 percent in an old sample of rabbitbrush (*Chrysothamnus nauseosus* (Pall.), Britton), and 9.46 percent in a plant of *Aplopappus nanus* (Nutt.) D. C. Eaton. Samples of guayule (*Parthenium argentatum* A. Gray) from plants growing near the United States Acclimatization Garden, Torrey Pines, Calif., analyzed at Bard, had a rubber content as high as 18.85 percent. Polhamus (7) reported a rubber content of 6.34 percent in the leaves of a goldenrod (*Solidago altissima* L.). Polhamus, Hill, and Elder (8), working with species of *Cryptostegia* in Florida, reported that the highest rubber content found in the leaves of *C. grandiflora* R. Br. was 3.34 percent; in the leaves of *C. madagascariensis* Boj., 3.14 percent; and in the leaves of a single plant of the interspecific hybrid, 8.6 percent.

TABLE 7.—*Rubber content of various species of Asclepias*

Species	Analyses	Part of plant analyzed	Rubber content		
			High	Low	Mean
	Number		*Percent*	*Percent*	*Percent*
Asclepias albicans S. Wats.[1]	12	Entire	4.42	0.88	2.11
A. brachystephana Engelm. (6)	1	do	3.00	2.10	2.50
A. californica Greene (3)	6	Leaves[2]	4.10	.90	2.76
A. erosa Torr.	50	do	13.06	2.45	8.57
A. galioides H. B. K. (6)	2	do	5.20	.62	
A. hallii A. Gray (6)	3	do	1.40	.80	1.07
A. latifolia (Torr.) Raf. (6)	7	do	3.70	1.00	2.03
A. linaris Schecht[1]	2	Entire	.85	.40	
A. mexicana Cav. (6)	12	Leaves	4.80	1.40	3.34
A. speciosa Torr. (6)	7	do	3.00	.99	2.10
A. subulata Decaisne (1)	203	Entire	6.00	.50	2.86
A. sullivantii Engelm. (6)	19	Leaves	8.10	1.20	3.75
A. syriaca L. (6)	10	do	4.40	.53	2.71

[1] Unpublished data recorded at U. S. Acclimatization Garden, near Bard, Calif.
[2] Leaves of various ages.

SUMMARY

Investigations with *Asclepias erosa* were conducted at the United States Acclimatization Garden near Bard, Calif., from 1931 to 1934.

The rubber content of the leaves of wild plants collected in Yuma County, Ariz., ranged from 2.45 to 13.06 percent, with a mean of 8.57 percent. The leaves represented over 50 percent of the dry weight of the plants, and contained approximately 90 percent of the rubber. A higher rubber content was obtained from the leaves of *A. erosa* than from any of the other milkweeds, and in habits of growth and ease of culture *A. erosa* compared favorably with other native and introduced plants.

Asclepias erosa is a herbaceous perennial, with 8 to 20 stems that average about 4 feet in height when mature. The new stems are produced in March and make rapid growth in the spring and early summer, reaching their maturity and their maximum rubber content in the autumn.

Leaves of *Asclepias erosa* were stored for 18 months without an appreciable loss in rubber content.

The seeds germinated readily, and the seedlings made rapid growth, either when planted in tar-paper pots or directly in the field, attaining a mean height of 14.8 inches the first season.

Progenies from plants with high, medium, and low yields of rubber were grown and analyzed. Many of the 1-year-old plants had a rubber content equal to 75 percent of that of the parents, and some of the progeny individuals, even in the first season, had a higher rubber content than that of the parents.

LITERATURE CITED

(1) BECKETT, R. E., and STIFF, R. S.
1935. THE DESERT MILKWEED (ASCLEPIAS SUBULATA) AS A POSSIBLE SOURCE OF RUBBER. U. S. Dept. Agr. Tech. Bull. 472, 20 pp., illus.

(2) FOX, C. P.
1911. OHIO GROWN RUBBER, CROP OF 1910. Ohio Nat. 11: 271-272, illus.

(3) ———
1912. ANOTHER OHIO GROWN RUBBER. Ohio Nat. 12: 469-471.

(4) GRAY, A.
1888. SYNOPTICAL FLORA OF NORTH AMERICA. Ed. 2, v. 2, pt. 1, 494 pp.

(5) HALL, H. M., and GOODSPEED, T. H.
1919. A RUBBER PLANT SURVEY OF WESTERN NORTH AMERICA. Calif. Univ. Pubs., Bot. 7: [159] 278, illus.

(6) ——— and LONG, F. L.
1921. RUBBER-CONTENT OF NORTH AMERICAN PLANTS. 65 pp., illus. Washington, D. C. (Carnegie Inst. Wash. Pub. 313.)

(7) POLHAMUS, L. G.
1933. RUBBER CONTENT OF VARIOUS SPECIES OF GOLDENROD. Jour. Agr. Research 47: 149-152.

(8) ——— HILL, H. H., and ELDER, J. A.
1934. THE RUBBER CONTENT OF TWO SPECIES OF CRYPTOSTEGIA AND OF AN INTERSPECIFIC HYBRID IN FLORIDA. U. S. Dept. Agr. Tech. Bull. 457, 23 pp., illus.

(9) SAUNDERS, A. T.
1910. RUBBER FOUND IN MILKWEED. India Rubber World 43: 4.

(10) SAUNDERS, W.
1875. ON THE MANUFACTURE OF RUBBER FROM A MILKWEED. Amer. Philos. Assoc. Proc. 23: 655-658.

ORGANIZATION OF THE UNITED STATES DEPARTMENT OF AGRICULTURE WHEN THIS PUBLICATION WAS LAST PRINTED

Secretary of Agriculture	HENRY A. WALLACE.
Under Secretary	M. L. WILSON.
Assistant Secretary	HARRY L. BROWN.
Director of Extension Work	C. W. WARBURTON.
Director of Finance	W. A. JUMP.
Director of Information	M. S. EISENHOWER.
Director of Personnel	W. W. STOCKBERGER.
Director of Research	JAMES T. JARDINE.
Solicitor	MASTIN G. WHITE.
Agricultural Adjustment Administration	H. R. TOLLEY, *Administrator.*
Bureau of Agricultural Economics	A. G. BLACK, *Chief.*
Bureau of Agricultural Engineering	S. H. MCCRORY, *Chief.*
Bureau of Animal Industry	JOHN R. MOHLER, *Chief.*
Bureau of Biological Survey	IRA N. GABRIELSON, *Chief.*
Bureau of Chemistry and Soils	HENRY G. KNIGHT, *Chief.*
Commodity Exchange Administration	J. W. T. DUVEL, *Chief.*
Bureau of Dairy Industry	O. E. REED, *Chief.*
Bureau of Entomology and Plant Quarantine	LEE A. STRONG, *Chief.*
Office of Experiment Stations	JAMES T. JARDINE, *Chief.*
Farm Security Administration	W. W. ALEXANDER, *Administrator.*
Food and Drug Administration	WALTER G. CAMPBELL, *Chief.*
Forest Service	FERDINAND A. SILCOX, *Chief.*
Bureau of Home Economics	LOUISE STANLEY, *Chief.*
Library	CLARIBEL R. BARNETT, *Librarian.*
Bureau of Plant Industry	E. C. AUCHTER, *Chief.*
Bureau of Public Roads	THOMAS H. MACDONALD, *Chief.*
Soil Conservation Service	H. H. BENNETT, *Chief.*
Weather Bureau	WILLIS R. GREGG, *Chief.*

This bulletin is a contribution from

Bureau of Plant Industry	FREDERICK D. RICHEY, *Chief.*
Division of Plant Exploration and Introduction.	B. Y. MORRISON, *Principal Horticulturist, in Charge.*

12

U. S. GOVERNMENT PRINTING OFFICE: 1938

For sale by the Superintendent of Documents, Washington, D. C. - - - - - Price 5 cents

END