

GENOTYPIC VARIATION IN THE PHACELIA HIRSUTA COMPLEX¹

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The *Phacelia hirsuta* complex is here defined to include *P. gilioides* Brand as well as *P. hirsuta* Nutt., and intermediate populations. Field and laboratory studies of these were carried out in conjunction with a biosystematic investigation of 10 species in the *Cosmanthus* group. The initial paper of this study (Gillett, in press) includes introductory comments and basic literature citations.

Both *Phacelia hirsuta* and *P. gilioides* are outcrossers and have 9 pairs of chromosomes. Experimental F_1 and F_2 hybrids have been produced. Each of these species is intersterile with the other 8 species of the *Cosmanthus* group. The *P. hirsuta* complex is separated from the other *Cosmanthus* phacelias by differences either in seed structure or in chromosome number (Gillett, op. cit.). The *P. hirsuta* complex has a distinct geographical status so that the combined genetical, cytological, morphological, and geographical information portrays this complex as a distinct evolutionary line.

The purpose of this paper is to show the variability of certain genotypic character differences between *Phacelia hirsuta* and *P. gilioides* and through these more clearly to portray their relationship.

These two species and their intergrades occur in an area extending nearly 700 miles north and south in the region between the eastern margin of the Great Plains and the Mississippi River. The more northern populations of central Missouri and southeastern Kansas are usually closer to the description of *P. gilioides*, while the southern populations usually fall within the circumscription of *P. hirsuta*. However, many populations in Arkansas, eastern Oklahoma, and southern Missouri cannot readily be assigned to either species.

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Phacelia gilioides is usually found on sparsely vegetated habitats in clearings of deciduous forests and frequently occurs on rocky barrens or limestone outcrops. On the other hand, *P. hirsuta* is usually found in more densely vegetated habitats in close association with grasses and weeds on stony to fine-textured soils of woodland clearings and roadsides. However, populations of the complex occur on a broad spectrum of habitats between these weakly-defined extremes.

The two species differ by several flower characters including corolla shape and color. However, because of the desirability of using herbarium specimens for the study of variability, only those characters readily apparent in dried material were studied. Those selected were: 1) the margin of the corolla lobes; 2) the width of the sepals; and, 3) the orientation of the cauline hairs (spreading to appressed). These are illustrated in Fig. 1.

A useful summary comparison of *Phacelia gilioides* and *P. hirsuta* is given in the following table:

<i>Phacelia gilioides</i>	<i>Phacelia hirsuta</i>
Corolla tube rotate at anthesis.	Corolla tube open-campanulate at anthesis.
Tube with distinct to faint purple mark on each lateral vein, or marks lacking.	Tube with distinct purple mark on each lateral vein, or these merging across the mid-vein.
Petal margins fimbriate.	Petal margins entire.
Sepals from $\frac{1}{2}$ to $\frac{3}{4}$ mm broad.	Sepals from $\frac{3}{4}$ to $2\frac{1}{2}$ mm broad.
Appressed cauline hairs.	Spreading cauline hairs.

The variability in each of the last three characters of the above table was determined either by direct measurement or by comparison. Voucher specimens were prepared from the parents employed in crosses and from one of the experimental F_1 hybrids and were used for scoring herbarium specimens. Three classes of expression were recorded for each character and these were plotted on the distribution map of Fig. 2. The expressions classified for each character included the two extremes, each with a representation of near-extremes, and an intermediate generally comparable to the expression in F_1 hybrids, but including some near-

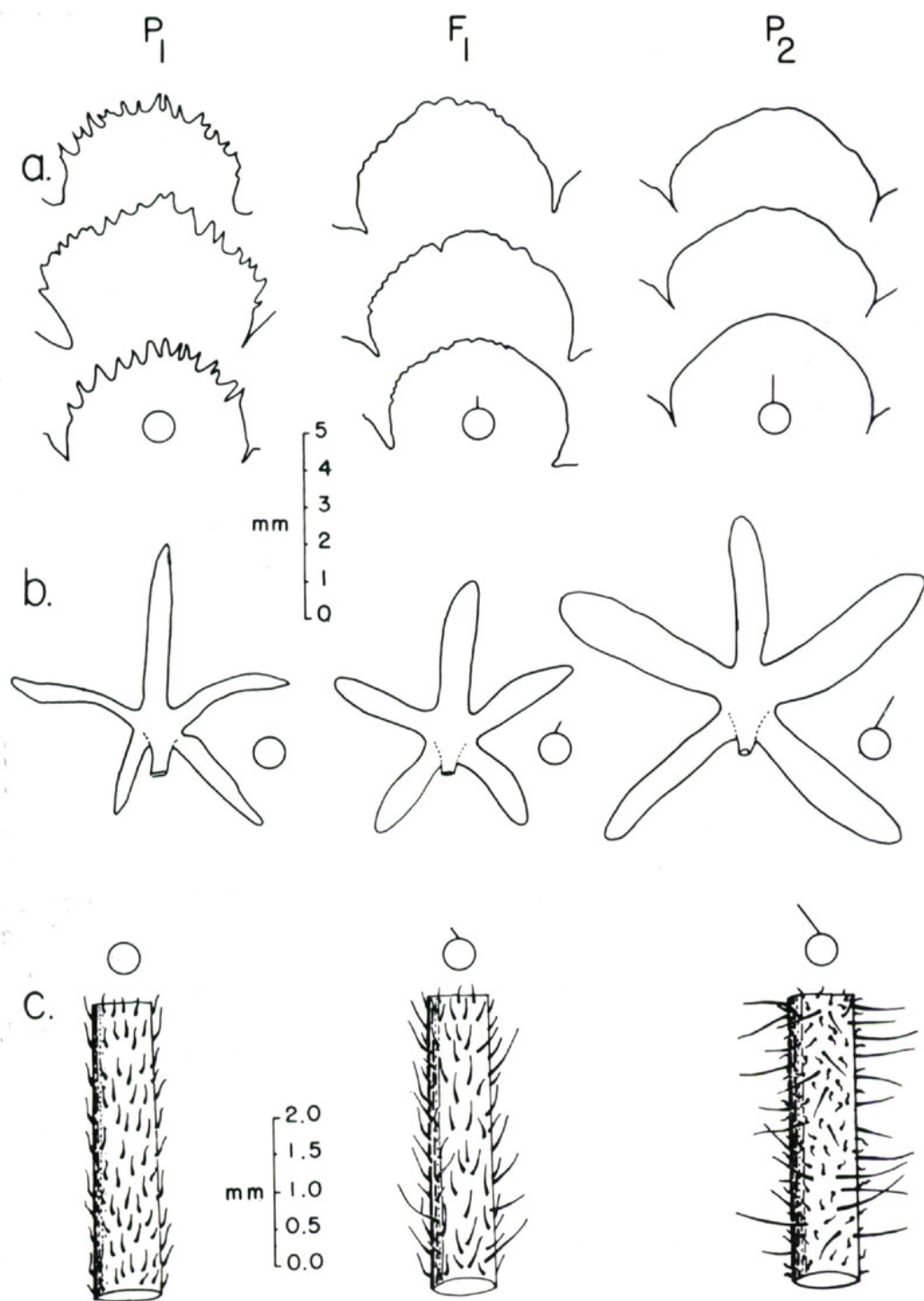


Fig. 1. Corolla margins (a), sepals (b), and cauline pubescence (c), expressed in *P. gilioides* (P_1), Gillett 1260; *P. hirsuta* (P_2), Gillett 1215; and experimental F_1 hybrid (center). Map symbols are below the corollas, to the right of the sepals, and above the stems.

intermediates on either side of this central expression. In other words, all three characters are metrical with several degrees of expression for each. These three categories are represented in map (Fig. 2) symbols as follows: the *Phacelia gilioides* extreme by the open circle; the intermediate category, similar to the expression in F_1 hybrids, by a line 1 mm long; and the *P. hirsuta* extreme by a line 2 mm long. The left-hand ray portrays cauline pubescence, the vertical ray corolla margin, and the right-hand ray sepal width. The three recognized classes of expression permitted a crude graphical portrayal of the variability for a particular character over the entire range of the complex. The scoring was accomplished by the procedures enumerated below.

COROLLA LOBES: This character was scored by direct comparison. The fimbriate margins with well-defined teeth characterize one extreme. This expression occurs in central and southeastern Missouri. The intermediate expression is found from the northern limit of the complex to northeastern Oklahoma and central Arkansas. The other extreme, the entire corolla margin, occurs in populations from southwestern Missouri to Texas and Louisiana.

SEPAL WIDTH: This character was measured by the ocular micrometer of a stereoscopic microscope. Normally, 11 sepals were measured on a given plant, these representing 5 mature flowers. The mean value was taken as the expression of central tendency. The narrow extreme (sepals .5 - .75 mm broad) is closely restricted to central and southeastern Missouri. However, the intermediate expression (sepals .75 - 1.00 mm broad) and the other extreme (sepals 1.0 - 2.5 mm broad) have remarkably wide distributions, each extending over almost the entire range of the complex.

CAULINE PUBESCENCE: This character was scored by direct comparison. The pubescence was recorded from the central axis of the plant, just below the mature inflorescence. One extreme is characterized by relatively short hairs that are abruptly bent at the base and have an appressed-ascending orientation with the stem. This expression is found in populations of central and southeastern Missouri, and in

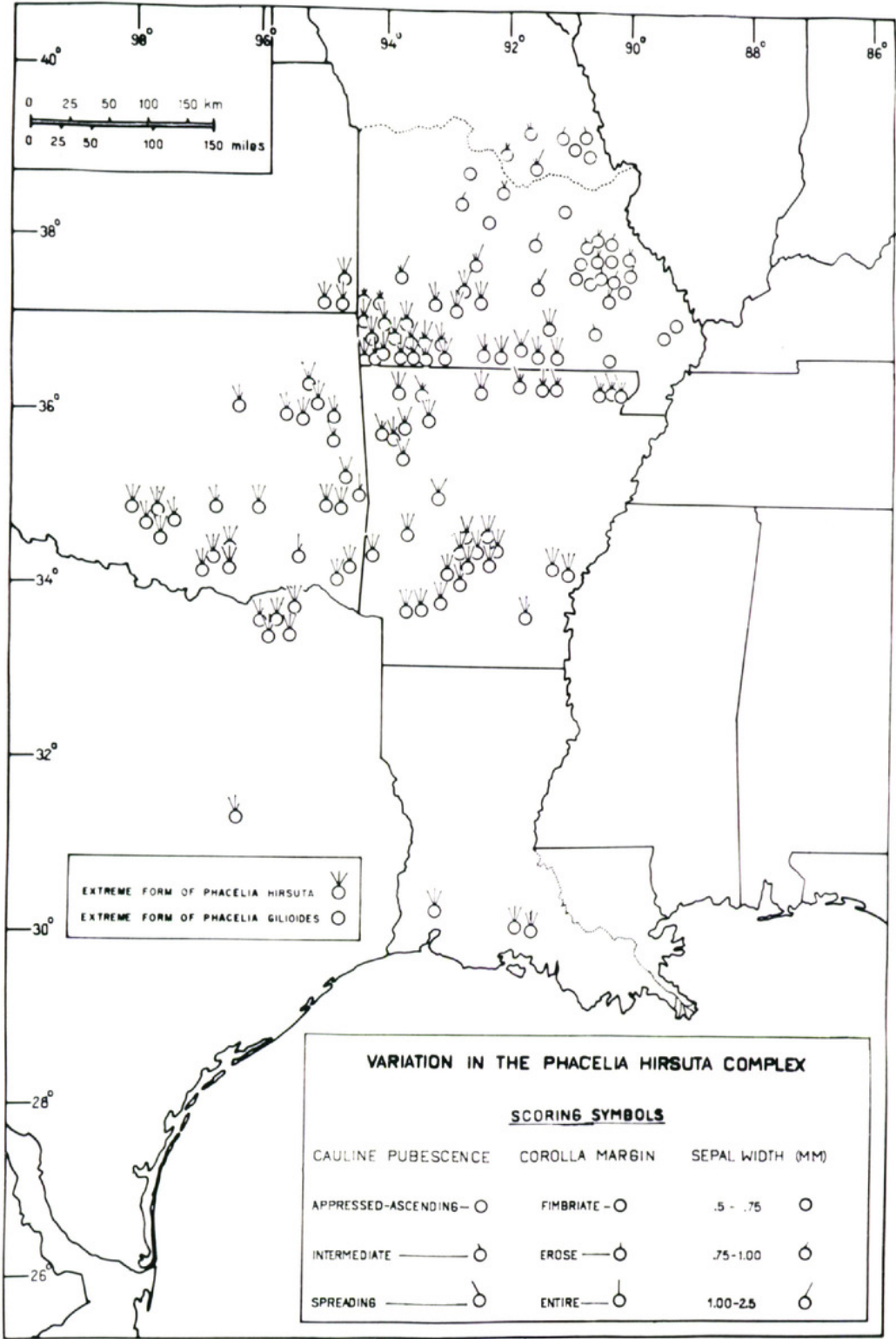


Fig. 2. Map showing distribution of variation in the *Phacelia hirsuta* complex.

isolated populations of eastern Oklahoma. The other extreme is typified by a pubescence of relatively long, spreading hairs and occurs in populations of south-central Missouri to Texas and Louisiana. However, the intermediate expression of cauline pubescence occurs in populations of central and southwestern Missouri, over a narrower range than either of the extremes.

The variation portrayed by this complex is suggestive of introgressive hybridization (Anderson, 1953; Stebbins, 1950), with the more northern *P. gilioides* and the southern *P. hirsuta* converging in southwestern Missouri and northern Arkansas, and subsequent bidirectional gene flow into both of the outbreeding parental stocks.

The variation outlined above is suggestive of that found in the *Phacelia sericea* complex (Gillett, 1961). In both cases it is impossible to make clear-cut taxonomic distinctions because of hybridization and the independent segregation of the genes that regulate character differences. The geographical variation in the *P. hirsuta* complex is so extensive that one feels obliged to recognize that the majority of populations of either species carry some genes of the other. It seems necessary, therefore, to distinguish these species in terms of relative differences imposed by relative gene frequencies rather than to take refuge behind the time-worn cliché "separated only with great difficulty" which implies that the taxa involved are indeed quite separable, but only with remarkable intuition. In this material it seems preferable to follow the suggestion of Dobzhansky (1951) and emphasize the geography of the genes rather than to impose a taxonomic distinction based on arbitrary judgment or hypothetical statistical differences, both of which tend to conceal the problem rather than to elucidate it.

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EULOPHIA ECRISTATA AND EPIDENDRUM CONOPSEUM IN MISSISSIPPI

According to the latest authority available to me (Native Orchids of North America North of Mexico, Donovan Stewart Correll, 1950) the present known range of *Eulophia ecristata* (Fernald) Ames is extremely disjunct with stations in North Carolina, Florida and Louisiana. I recall collecting it some fifteen years ago in Georgia. It was almost a certainty that sooner or later it would turn up in the intervening territory. This past summer while collecting in a low lying, grassy savanna within the western limits of the town of Picayune I found a small colony of three plants. Close associates were various species of *Panicum* and *Paspalum* while nearby were such genera as *Stokesia*, *Eupatorium*, *Gerardia*, *Chondrophora*, *Solidago*, and *Helianthus*. The *Eulophia* was in bloom on Aug. 21st. A few days later I found a single specimen about eight miles to the northwest in open, grassy pineland. A specimen has been deposited at the University of Mississippi.

Curiously enough almost the same pattern applies to the range of *Epidendrum conopseum* R. Br. This past winter I noticed its leaves about ten feet up on the trunk of *Nyssa* in a wooded overflow swamp two miles west of Picayune. About the middle of July, in company with Dr. Thomas M. Pullen, it was collected in flower.

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Gillett, George W. 1965. "Genotypic variation in the *Phacelia hirsuta* complex [Hydrophyllaceae]." *Rhodora* 67, 42–48.

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