The Red and Black Oaks of Indiana

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Introduction

The number of species of red and black oaks (*Quercus* subgenus *Erythrobalanus* (Spach) Oersted) in Indiana has been reported variously as nine or ten. A simple count does not suffice because all authors do not recognize the same species. Specifically, many authors treat the cherrybark oak as *Q. falcata* Michaux var. *pagodaefolia* Ell. while others consider it a distinct species, *Q. pagoda* Ashe. If however, allowance is made for such taxonomic problems, there is still a slight discrepancy. That is, there has been some disagreement about which species actually occur in the state.

Deam (5) in a comprehensive treatment of the trees of Indiana, reported nine species. Eight years later, Deam (6) reported the same nine species but the recorded distributions of several of these had been markedly expanded. Other authors apparently have based their reports on Deam's (6) maps. Little (16, 17) presented maps, for the same taxa, that are virtual duplicates of Deam's (6) maps. Elias (7) followed suit, but apparently relied on Little (16, 17) as his sources. Preston (21) reported one species, *Q. nigra* L., not included by other authors. Furthermore, he indicated that *Q. marilandica* Muenchh. occurs throughout Indiana while Deam (6), Little (16), and Elias (7) depicted this species as occurring only in the southwest and southcentral portions of the state. In a more recent edition, Preston (22) adopted Little's (16, 17) maps and no longer included *Q. nigra* among the species found in Indiana. Thus, by virtue of Deam's (6) revision, followed by gradual adoption of his maps by others, there is now an apparent agreement on the number of species of red and black oaks in Indiana as well as on the distribution of these species. Of course, this agreement is not a reflection of congruence between the research findings of different authors. Rather, it is a function of later authors relying on Deam's (5, 6) work as a source for their own reports.

A second aspect of the recorded occurrence of red and black oaks in Indiana is the small number of hybrids that have been reported. Hybrids, or at least trees thought to be hybrids, are encountered commonly in mixed oak forests. The existence of hybrid individuals has been confirmed by morphological studies (12, 13, 14) and by chemical studies (15). All species of *Erythrobalanus* native to Indiana have been identified as progenitors of hybrid trees (20), yet very few hybrids have been reported from Indiana. Deam (5) reported only two hybrids among the many specimens he examined: one specimen of X *Q. exacta* Trel. from Posey County and two specimens of X *Q. leana* Nutt., *pro sp.*, one each from Lawrence and Lake Counties. Both of these hybrids involve *Q. imbricaria* Michaux as one parent, with *Q. palustris* Muenchh. and *Q. velutina* Lam., respectively, being the second parents. In 1940, Deam (6) added one more hybrid to this list, X *Q. bushii* Sarg. (*Q. marilandica* x *Q. velutina*), based on a single specimen from Knox County. While hybrids between morphologically distinct species such as the above-mentioned are rather easily identified, it is not surprising that Deam (5, 6) reported so few hybrids. After all, most hybrids that could be expected to occur in Indiana would involve parent species that are morphologically very similar, thus making the hybrid difficult to detect.

Palmer (20), in a comprehensive list of hybrid oaks found in North America, reported only two additional hybrids from Indiana: X *Q. paleolithicola* Trel. (*Q. ellip-*

soidalis E. J. Hill x *Q. velutina*) and X *Q. runcinata* (A. DC.) Englem. (*Q. imbricaria* x *Q. borealis* Michaux f.). Palmer's (20) paper is the most thorough survey of oak hybrids published to date. Since its publication, there has been no attempt to update the literature. A number of new hybrids have been described, but none has been noted specifically as occurring in Indiana. Nor has there been any general survey of additional hybrid reports from various parts of the country. Therefore, our current knowledge of hybrid oaks that may occur in Indiana is essentially the same as it was thirty-four years ago.

The research reported here had two primary goals. First, the distribution of each species of red or black oak native to Indiana was to be brought up to date and an attempt was to be made to verify the county records reported in Deam (5, 6). Second, an annotated list of red and black oak hybrids found in Indiana was to be prepared and, again, Deam's (5, 6) reports were to be checked.

Materials and Methods

The distributions of red and black oaks in Indiana were determined primarily by examination of specimens on file at various herbaria in Indiana, Illinois, and Ohio. The herbaria visited were those at Ball State University (BSU), Butler University (BU), DePauw University (DPU), Earlham College (EC), the Field Museum (F), Indiana University(IND), Miami University (MU), Purdue University (PUL), St. Mary's College (SMC), the University of Illinois (ILL), the University of Notre Dame (ND), and Wabash College (WAB). As specimens were examined, a record of county occurrences was made by entering label information into a data file. The file was prepared using the MicroLibrarian© program with an OSBORNE-1 portable microcomputer.

A data entry was not made for every specimen examined. Rather, an entry was made for the first specimen of each taxon which could be verified for each county. Once a county record was entered, no additional entries for that taxon in that county were made. Thus, the list of verified county records is top-heavy with specimens from the first several herbaria visited. On the other hand, all specimens labeled or verified as hybrids were recorded. In addition, several reports are based on my own specimens collected during September, 1983. These specimens eventually will be filed in the Indiana University Herbarium (IND).

The files generated could be scanned by taxon and by county to prepare distribution maps. These maps were prepared to reflect (1) the distribution based on my data files, (2) the distribution reported by Deam (5, 6), (3) new records since Deam's last treatment (6), and (4) records reported by Deam (6) that could not be verified by correctly identified herbarium specimens.

The complete data file is housed on three floppy disks and comprises over six hundred entries. As such, it is too large for inclusion here. If anyone desires a copy of the file, sequenced either by taxon or by county, the author will provide same upon receipt of a written request.

Results and Discussion

The results are presented in alphabetical order of the species epithets. When herbarium specimens are cited, the format is to present the herbarium abbreviation (see above) and accession number followed by the collector's name and collection number.

I. *Quercus borealis* Michx.

This is one of the more commonly encountered oak species in Indiana and, while the maps in Deam (6; map 790) and Figure 1 indicate many gaps, probably can be found in every county. Although I was able to verify most of Deam's records and added eighteen additional records, including two collected by me (Whitley Co., *Jensen*

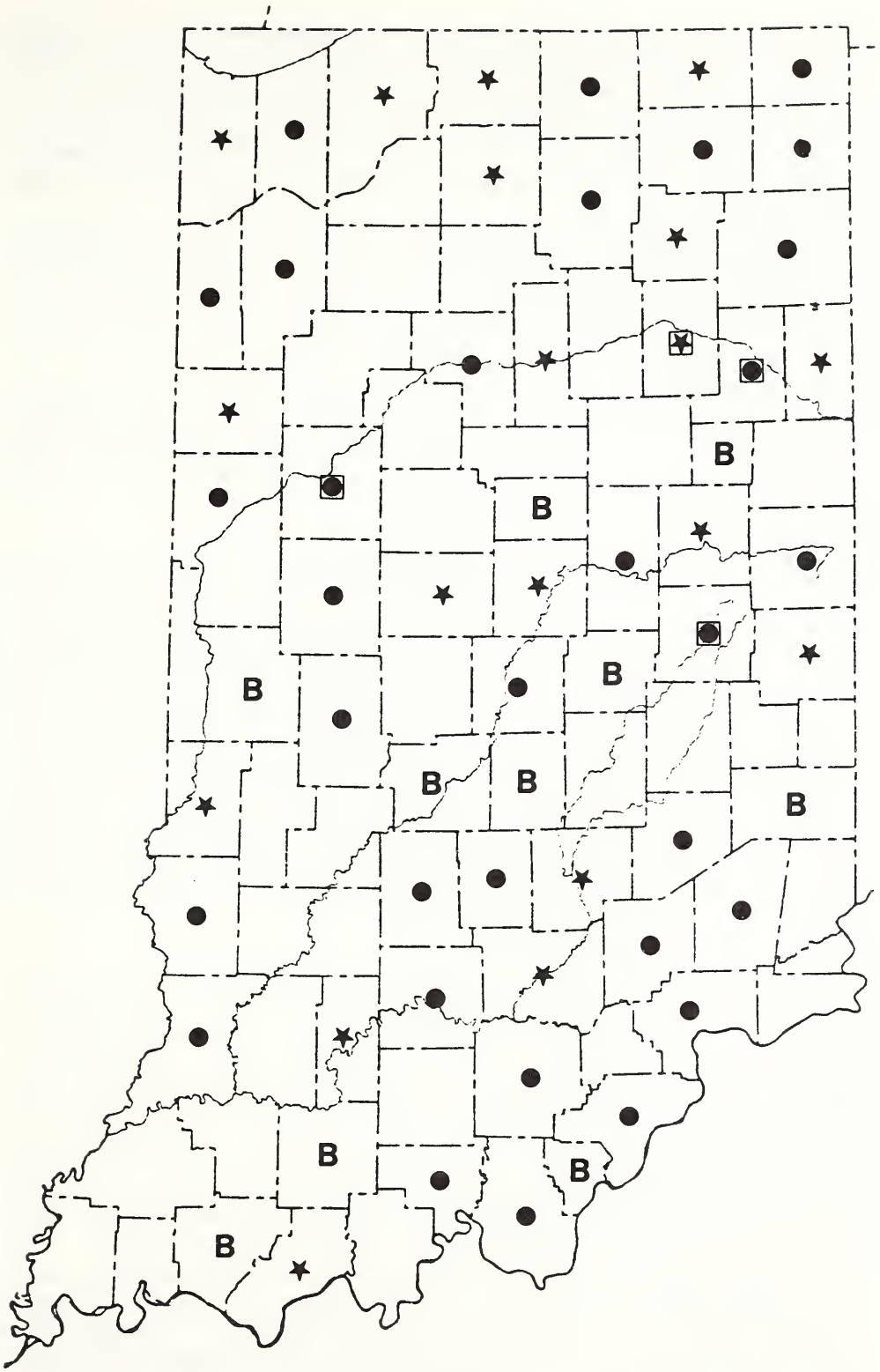

FIGURE 1. *Quercus borealis* in Indiana. In this, and all other figures, ● = mapped in Deam (1940) and verified by existing specimens; ★ = not mapped by Deam, but verified by existing specimens; a letter signifies that that county was mapped in Deam, but could not be verified and the letter reflects the herbarium Deam cited, B = Butler; □ = *Q. borealis* var. *borealis*.

83-40; LaPorte Co., *Jensen* 83-18), there were 10 county records on Deam's map which could not be verified. All 10 of these were, according to Deam, based on specimens housed at Butler University. Those specimens, if at Butler, are not housed in the herbarium with the other oaks. In addition, there are literature reports for *Q. borealis* in twelve other counties: Clay (28), Daviess (19), Fayette (25), Fulton and Grant (24), Greene (19), Howard (8, 24), Owen (29), Switzerland (9), Union and Vermillion (26), and White (24).

Many of the specimens examined did not have fruits, therefore it is difficult to assess the range of *Q. borealis* var. *borealis*, the smaller fruited and less common variety of this species. As indicated in Figure 1, only four specimens of this variety were found, all others being *Q. borealis* var. *maxima* (Marsh.) Ashe or, for lack of fruits, were merely identified to the species.

Even though Deam (6) stated that this species "may be entirely absent from Benton, Newton, and possibly Lake Counties . . ," his map (790) shows it in Newton County. While, as shown in Figure 1, it also occurs in Benton and Lake Counties, there is still validity to his comment that it "is rare or absent in the lower Wabash Valley."

II. *Quercus coccinea* Muenchh.

Deam (6) reported this species from only 13 counties (Figure 2) in Indiana, remarking that ". . . is local and, no doubt, has a wider range than the map indicates." As Figure 2 illustrates, Deam was right. Although I added only 19 counties to those mapped by Deam (6), the distribution suggests that *Q. coccinea* may be expected to occur throughout the state. I was unable to verify two of Deam's (6) county records (Floyd and Sullivan Counties) and found a discrepancy in his text. *Quercus coccinea* var. *tuberculata* Sarg. is reported as occurring in Vanderburgh County, yet this is not indicated on the map (Deam's [6] map 795). As shown in Figure 2, I was able to verify the occurrence of var. *tuberculata* in 13 counties and its distribution suggests that both varieties of *Q. coccinea* are probably common in the state. Two other counties, not marked in Figure 2, perhaps should be included. Hale (9) reported *Q. coccinea* from Switzerland County and Underwood (27) reported collecting *Phyllactinia suffulta* from *Q. coccinea* in Johnson County.

III. *Quercus ellipsoidalis* E.J. Hill

This species is confused easily with *Q. coccinea* and in northern Indiana, where their ranges overlap, it is difficult to distinguish the two. There were a number of sterile specimens, of one of these two, which I was not able positively to identify to species. Generally, these two species can be separated by the shape of the nut, which tends to be elliptic in *Q. ellipsoidalis* and sub-globose in *Q. coccinea*. However, both taxa are variable in this respect. Another character which may be used is the presence of rings of minute pits around the apex of the nut. This feature is more common in *Q. coccinea*, although it occasionally may be expressed in *Q. ellipsoidalis*. Sterile specimens, especially in northern Indiana, are very difficult to identify, although careful multivariate analyses indicate that this can be done (Jensen, unpublished).

I have no evidence that *Q. ellipsoidalis* occurs south of a line extending roughly from the Benton-Warren County line in the west to Adams County in the east (Figure 3). Deam (6) stated, for *Q. ellipsoidalis*, that its "distribution . . . in Indiana is not known" and he reported it from only three counties. I have verified the identity of specimens from these three counties as well as an additional sixteen counties in Northern Indiana. As Deam (6) noted, Andrews (1) reported *Q. ellipsoidalis* from Monroe County, a report probably based on misidentification of either *Q. coccinea* or *Q. palustris*.

IV. *Quercus falcata* Michx.

This complex assemblage consists of many named variants, of which Deam (6)

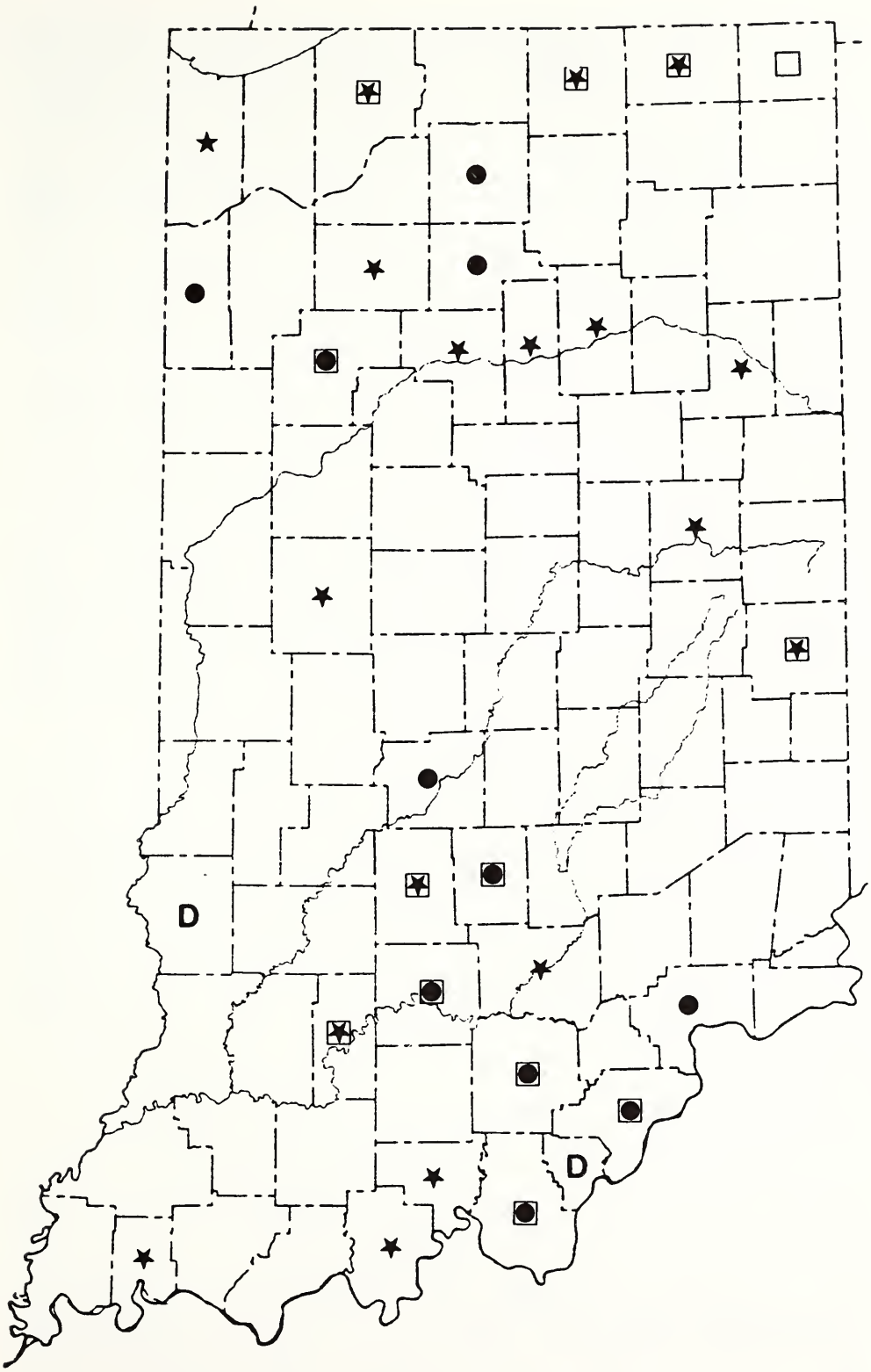

FIGURE 2. *Q. coccinea* in Indiana. □ = var. *tuberculata.* D = Deam's Herbarium (now at IND).

recognized four: *falcata* var. *falcata, falcata* f. *triloba* (Michx.) Palmer and Steyerm.,

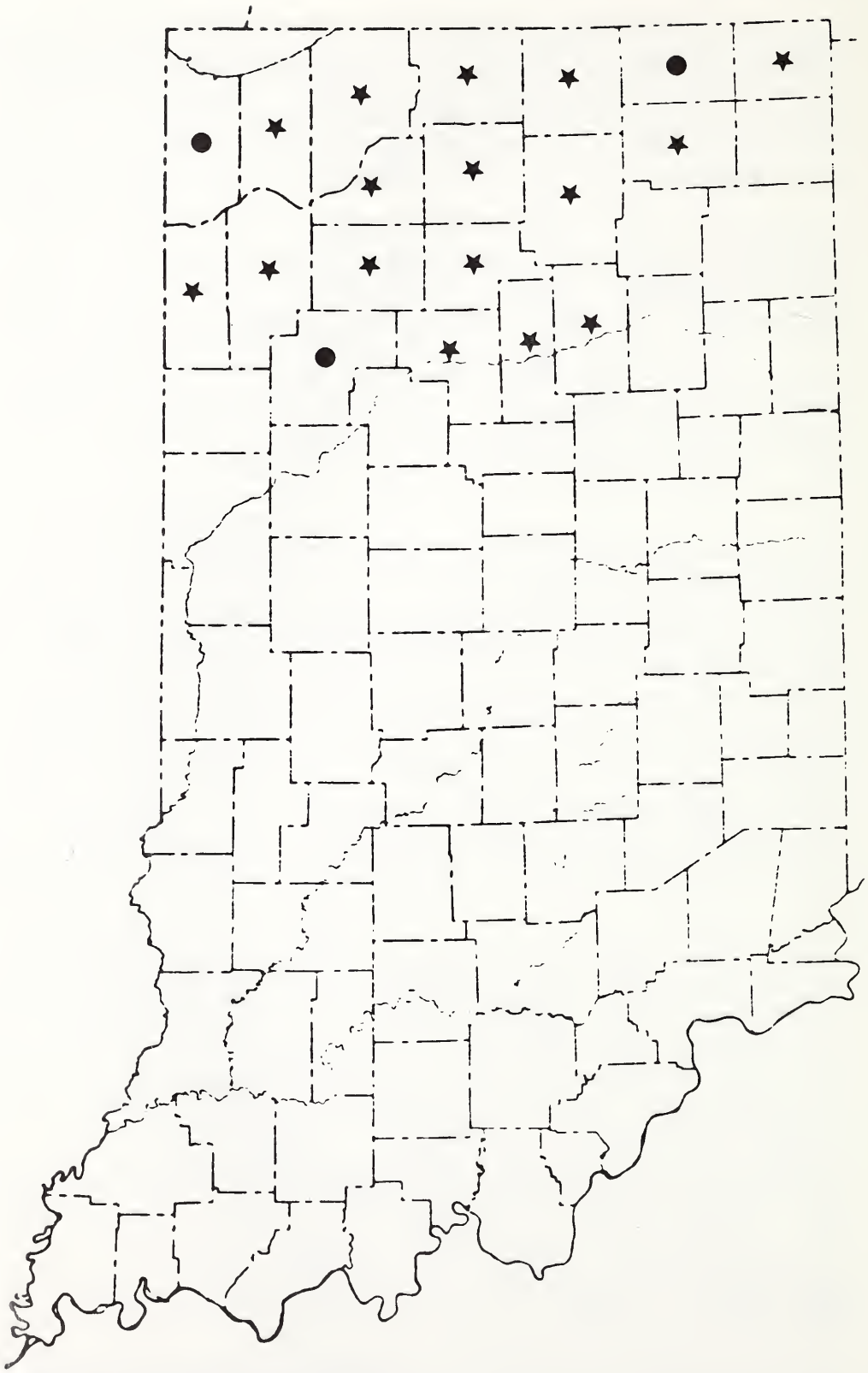

FIGURE 3. *Q. ellipsoidalis* in Indiana.

falcata var. *leucophylla* (Ashe) Palmer and Steyerm., and *falcata* var. *pagodaefolia* Ell. Yet in his mapping of distributions (map 796), he lumped all under *falcata* sensu

lato. Thus, the distribution of each variety or form can be deduced only from the text; *f. triloba* apparently occurs throughout the area mapped, variety *leucophylla* was reported only from Posey County, and variety *pagodaefolia* was reported only from Posey and Gibson Counties.

I have chosen to follow Ware (30), Jensen (11), and Hicks and Burch (10) by viewing this complex as comprising two species: *Q. falcata* and *Q. pagoda* Ashe. The former includes forma *triloba* and the latter includes variety *leucophylla*. Figures 4 and 5 present the distributions of these two species based on specimens I have examined. For *Q. falcata*, my map is almost identical to Deam's (6), although I have added one county (Greene) and was unable to verify its occurrence in two others (Knox and Jennings). The Knox Co. record was based on an IND specimen (IND 3336 = *Welch* and *Pocket* 4996), annotated as *Q. falcata* by Deam, which is from *Q. pagoda*. No specimen of any form or variety of this complex was found for Jennings County. In addition to the five counties indicated in Figure 5, *Q. pagoda* has also been reported from Franklin County (4), although no specimen was found to verify this report.

V. *Quercus imbricaria* Michx.

This species, easily identified because it is the only entire-leaved oak in Indiana, was reported from forty counties throughout the state by Deam (6). Each of Deam's reports could be verified along with an additional thirteen records not included in Deam's work. One of these, for Wabash County, was made by me (*Jensen* 83-30) during September, 1983. Based on the distribution shown in Figure 6, it is probably safe to assume that this species occurs in many of those counties lacking records. Andrews (1) did report *Q. imbricaria* from Monroe County.

VI. *Quercus marilandica* Muenchh.

Deam (6) reported this species to be "local and infrequent, mostly in the southwestern part of the state. . . ." Figure 7 is very similar to Deam's map 797; no new records have been added, but two could not be verified. I was unable to find a specimen from Jackson County and the two specimens at IND from Lawrence County were both misidentified. *Cain* 100 (IND 3382) is a specimen of X *Q. leana* Nutt. In his 1931 report on the flora of Spring Mill State park, Cain (2) included *Q. marilandica*, but noted that the identification was based on a single questionable specimen. *Wible* 234 (IND 3381), while not *Q. marilandica*, appears to be X *Q. bushii* Sarg., a hybrid having *Q. marilandica* as one of its parents. Thus, *Q. marilandica* must be in Lawrence County, it is just that no confirmed specimen is on file.

VII. *Quercus palustris* Muenchh.

This is a very common species throughout Indiana as indicated by Figure 8 and by Deam's (6) map 792. I was able to verify every county record reported by Deam as well as collections for an additional 27 counties. Deam (6) commented that this species "may be absent from Benton County," but a PUL specimen (6958 = *R. Kriebel* 5147) from Benton Co. is certainly this species. Deam (6) also noted that there appear to be two forms of this species differing in nut size, with the more common form having larger nuts. However, Deam did not specify what the sizes of the nuts are. In my experience, the common form in Indiana is the typical small-fruited pin oak found throughout the mid-eastern United States. I encountered a single tree in Huntington County (*Jensen* 83-31) which had fairly large nuts, measuring almost 2.0 cm in length and diameter. Otherwise, the specimens I have collected and examined had nuts generally less than 1.5 cm in length and diameter. This species probably occurs also in Shelby County for which Underwood (27) reported having found *Phyllactinia suffulta* growing on pin oak. However, there appear to be no specimens on file.

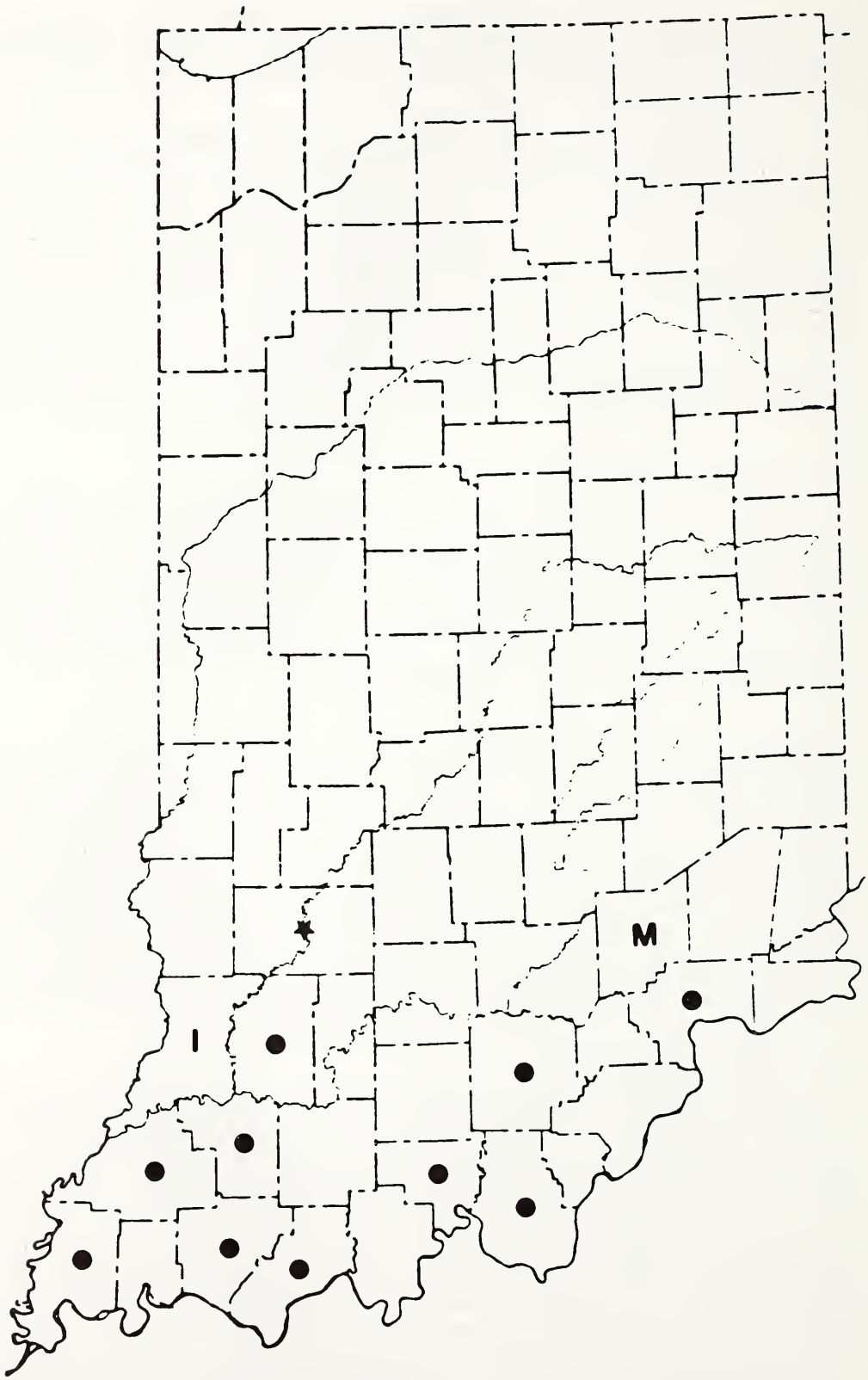

FIGURE 4. *Q. falcata* in Indiana. I = Indiana University; M = Herbarium of Scott McCoy.

FIGURE 5. *Q. pagoda* in Indiana.

VIII. *Quercus shumardii* Buckl.

The distribution of this species probably has been better documented than that

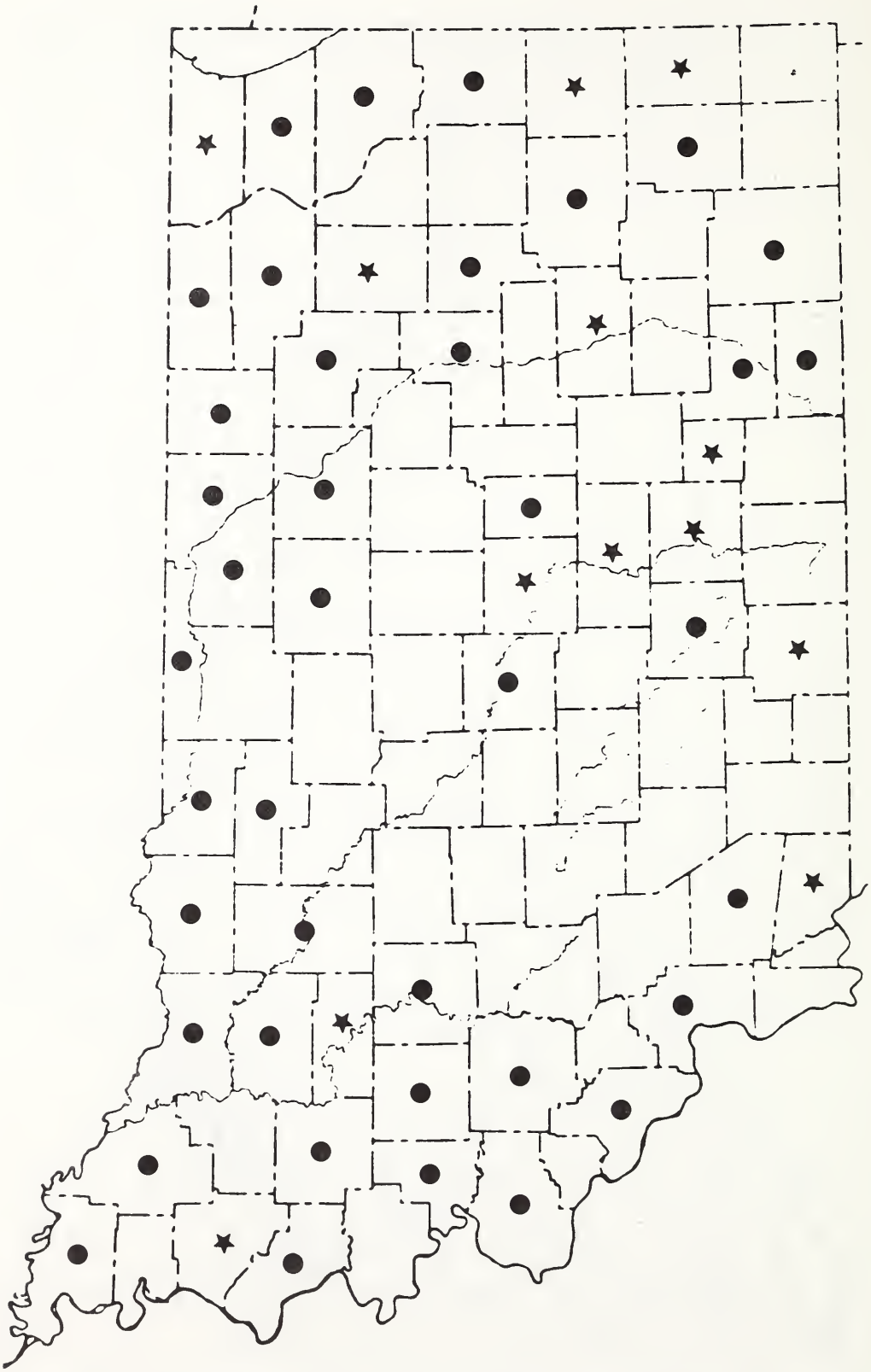

FIGURE 6. *Q. imbricaria* in Indiana.

of any other oak. Kriebel conducted an extensive search for it during the late 1930s and many herbaria, particularly BU, IND, DEP, and PUL, contain duplicates of his

FIGURE 7. *Q. marilandica* in Indiana. I = Indiana University; K = Herbarium of Ralph Kriebel.

collections. Most of the reports illustrated in Figure 9 are based on specimens collected

FIGURE 8. *Q. palustris* in Indiana.

by Kriebel. As can be seen by comparison with Deam's (6) map 793, my map does not represent a significant change. Two of the county reports by Deam, for Carroll

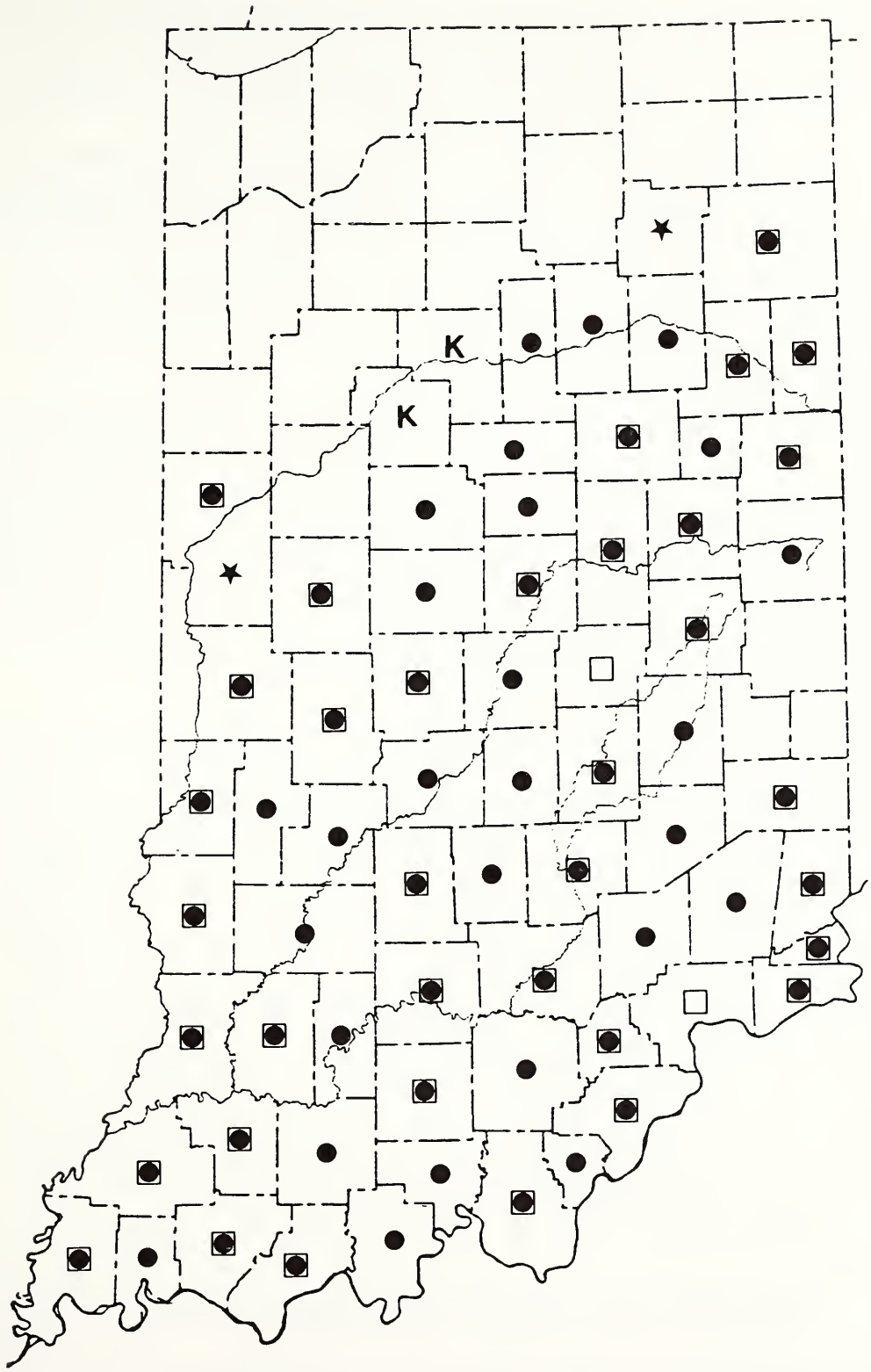

FIGURE 9. *Q. shumardii* in Indiana. □ = var. *schneckii*. K = Herbarium of Ralph Kriebel.

and Cass Counties, could not be verified, while two others, Fountain and Whitley Counties, have been added. The last is based on several specimens I collected in the

south-central part of Whitley County. As noted by Deam (6), Kriebel did not find *Q. shumardii* in Benton County or in the northwest part of the state. None of the specimens I examined came from that part of the state. In addition to the counties shown in Figure 9, this species was reported from Vermillion County by Coulter (4), but no specimen was found to verify this report.

As does *Q. borealis, Q. shumardii* has two varieties differentiated primarily by acorn size. Deam (6) did not provide any details on the distribution of the two varieties beyond noting that var. *schneckii* (Britt.) Sarg. ranges "northw. (sic) in the Mississippi Valley to Wells County, Indiana." Whenever possible, I noted the variety for each specimen examined and I have indicated their joint distributions in Figure 9. There is no apparent difference in the distributions of the two varieties, although there are two counties, Jefferson and Hancock, for which only var. *schneckii* has been reported.

IX. *Quercus velutina* Lam.

This is probably the most common oak in Indiana and Deam (6) stated that it is "without doubt found in every county of the state." Figure 10 shows it to be recorded from 66 counties. Deam also reported *Q. velutina* from Crawford, Parke, Perry, and Pike Counties. No specimens were found for the first three of these and the single specimen found from Pike County (IND 39321 = *Deam* 18353) was misidentified. Two of the records shown in Figure 10, those for Huntington and Whitley Counties, are based on specimens (*Jensen* 83-33 and 83-44) I collected during September, 1983.

In addition to the records illustrated in Figure 10, there are literature references indicating that *Q. velutina* also may be found in six other counties: Clay (28), Jennings (19), Martin (23), Orange (24), Switzerland (9), and Wayne (18).

X. Hybrids

The most frequently recorded hybrid is X *Q. leana* Nutt., which has been found in 13 counties in Indiana (Figure 11). Deam (6) reported this hybrid from only three counties, but the tree on which his Lake County report (IND 18546, 18707, 70361 = *Deam* 18088) was based actually belongs in X *Q. runcinata*. Deam's report of X *Q. exacta* from Posey County (IND 18560, PUL 6701 = *Deam* 29116) was based on another tree which also appears to belong in X *Q. runcinata*. Thus, the occurrence of X *Q. exacta* has not been verified for Indiana. Deam's third hybrid report could be verified. Besides occurring in Knox County, X *Q. bushii* also occurs in Spencer and, possibly (as noted under discussion of *Q. marilandica*), Lawrence Counties.

There are two specimens of X *Q. benderi* Baenitz (*Q. borealis* X *Q. coccinea*), annotated as such by E.J. Palmer, on file: IND 70236 (*Deam* 62074) and PUL 7282 (*Kriebel* 10053). These specimens apparently came from the same tree; they were collected on consecutive days (October 5 and 6, 1942) in the southeast quarter of section 24 of Wells County. The specimens are, however, not of a hybrid but, rather, are from a tree of *Q. shumardii*. There is another specimen which may be this hybrid. Collected in Montgomery County, this specimen (WAB 5761 = *Beckel s.n.*) was identified as *Q. coccinea*, but probably belongs in X *Q. benderi.*

Other hybrids, and the counties for which records have been verified, are given below:

X *Q. runcinata*—Adams, Delaware, Gibson, Lake, Lawrence, Porter, St. Joseph, Wells, and possibly Kosciusko, Morgan and Tipton;

X *Q. paleolithicola*—Elkhart, Lagrange, and possibly Kosciusko;

X *Q. hawkinsii* Sudw.—Lake, Laporte, Porter, Vigo;

X *Q. tridentata* (A. DC.) Engelm.—Crawford.

FIGURE 10. *Q. velutina* in Indiana. B = Butler University; D = Deam's Herbarium.

Two other putative hybrids, X *Q. mutabilis* Steyerm. (*Q. palustris* x *Q. shumardii*) and X *Q. vaga* Palmer & Steyerm. (*Q. palustris* x *Q. velutina*) may occur in Gibson

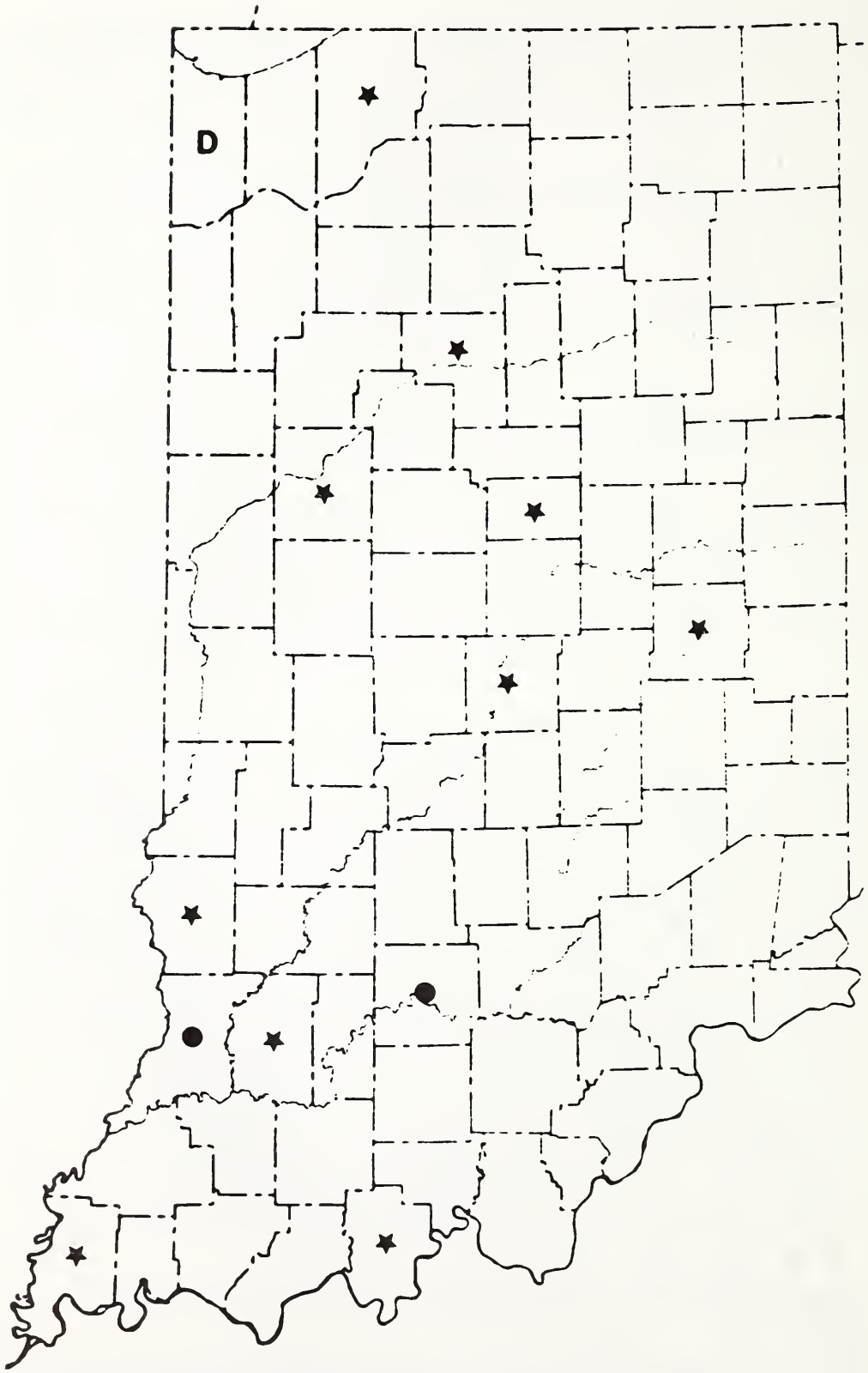

FIGURE 11. X *Q. leana* in Indiana. D = Deam's Herbarium.

and Porter Counties, respectively. The specimens examined give the appearance of being these hybrids, but the identification is tentative. Recently, one of my students

and I have conducted both morphological and chemical studies indicating that X *Q. vaga* occurs in St. Joseph County. Research is being continued in order to verify its occurrence. A complete list of specimens on which these hybrid reports are based is available from the author on request.

XI. Excluded Taxa

As noted in the introduction, *Q. nigra* L. was shown to be in Indiana by Preston (21). I found a single specimen (WAB *s.n.* = *Clapp s.n.*), collected near New Albany in 1836, identified as *Q. nigra*. Deam had correctly annotated this specimen as *Q. marilandica*. Interestingly, Coulter (3) cited a Deam specimen from Crawford County in support of his claim that *Q. nigra* is fairly well distributed throughout the state, near streams and swamps, sometimes in upland regions. I don't know which species Coulter was describing, because there is no other taxon of *Quercus*, found in such habitats in Indiana, that even remotely resembles *Q. nigra*. The confusion regarding this taxon is exacerbated by Andrews' (1) report that it is also found in Monroe County. The only specimen of *Q. nigra* that I have located, from Delaware County (BSU 1273 = *Hughes s.n.*), was originally identified as *Q. nuttallii* Palmer. Undoubtedly, this specimen was taken from a tree planted somewhere near the Ball State University campus.

Quercus phellos L. also should be excluded. Coulter (3) noted that reports of this species probably were based on misidentification of a narrow-leaved tree of *Q. imbricaria*. I came across two specimens of *Q. phellos* (BU 96603 = *Friesner* 24804; BSU 1278 = *Olsen s.n.*), both of which must have come from planted trees. The former was collected in Versailles State Park, Ripley County, and the latter in Muncie, Delaware County.

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