SYSTEMATIC POSITION OF CNIDOSCOLUS AND JATROPHA

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The species of *Cnidoscolus* and *Jatropha* (Euphorbiaceae) have generally been closely associated in systematic literature since Linnaeus (1753) included representatives of both in his comprehensive genus *Jatropha*. Adanson (1763) and Mueller (1866) followed the Linnaean concept, whereas Grisebach (1864), Pax and Hoffmann (1931) and McVaugh (1944, 1945) have upheld *Cnidoscolus* as generically distinct. McVaugh presented an impressive array of generic distinctions for *Cnidoscolus,* including its single (rather than double) floral envelope, repeatedly dichotomous styles, stinging hairs, petiolar glands, and chambered pith. The problem of generic definition in the *Jatropha*-complex, however, is complicated by the fact that a number of groups other than *Cnidoscolus* have been segregated from *Jatropha*. Britton and Wilson (1924), for instance, placed *J. curcas* in the genus *Curcas* and *J. gossypifolia* in *Adenoropium*. Small (1913) referred *J. dioica* to the segregate genus *Mozinna*. Furthermore, León (1941) has taken two remarkable West Indian species out of *Cnidoscolus* as a separate genus *Victorinia*.

One of the main areas of interest in the program of evolutionary studies on Euphorbiaceae at Purdue deals with the comparative morphology of the American genera of Crotonoideae related to *Croton* and *Jatropha*. A study by the senior author (1961) includes observations which have a bearing on the *Cnidoscolus-Jatropha* problem in particular. In some respects, such as stomatal type and venation, there appear to be no significant differences between the genera. The evidence which is especially interesting is that yielded by studies of petiolar anatomy, pollen morphology, and cytology.

Petiolar anatomy proved to be significant in demonstrating relationships in *Cnidoscolus* and *Jatropha* at both the generic and intrageneric levels. Dehay (1935), in his survey of Euphorbiaceous petiolar anatomy, reported only on *Jatropha curcas* and did not mention *Cnidoscolus,* nor do any other workers appear to have done so. Our observations are based on the examination of free-hand sections of the petioles of 9 taxa of *Jatropha* and 2 species of *Cnidoscolus*. Sections were made at three levels (base, middle, and junction with blade), stained with phloroglucinol and hydrochloric acid, and mounted in Hoyer's medium (Beeks 1955).

In both genera the petiole is relatively massive and ranges in length from a few centimeters up to 1 or 2 decimeters. In accordance with the terminology of Dehay, the vascular cylinder may be described as consisting of an abaxial semi-circular strand of xylem and phloem with an adaxial plate of xylem and phloem closing the gap between the ends of the abaxial arc.

In *Jatropha* (Figs. 1–8) a section at the basal end of the petiole of a given species shows a relatively constant number of collateral vascular traces. These bundles converge distally to form a siphonostele which persists through most of the length of the petiole, until they separate at the base of the lamina and enter mesophyllar tissue. These distally separating traces are strikingly out-

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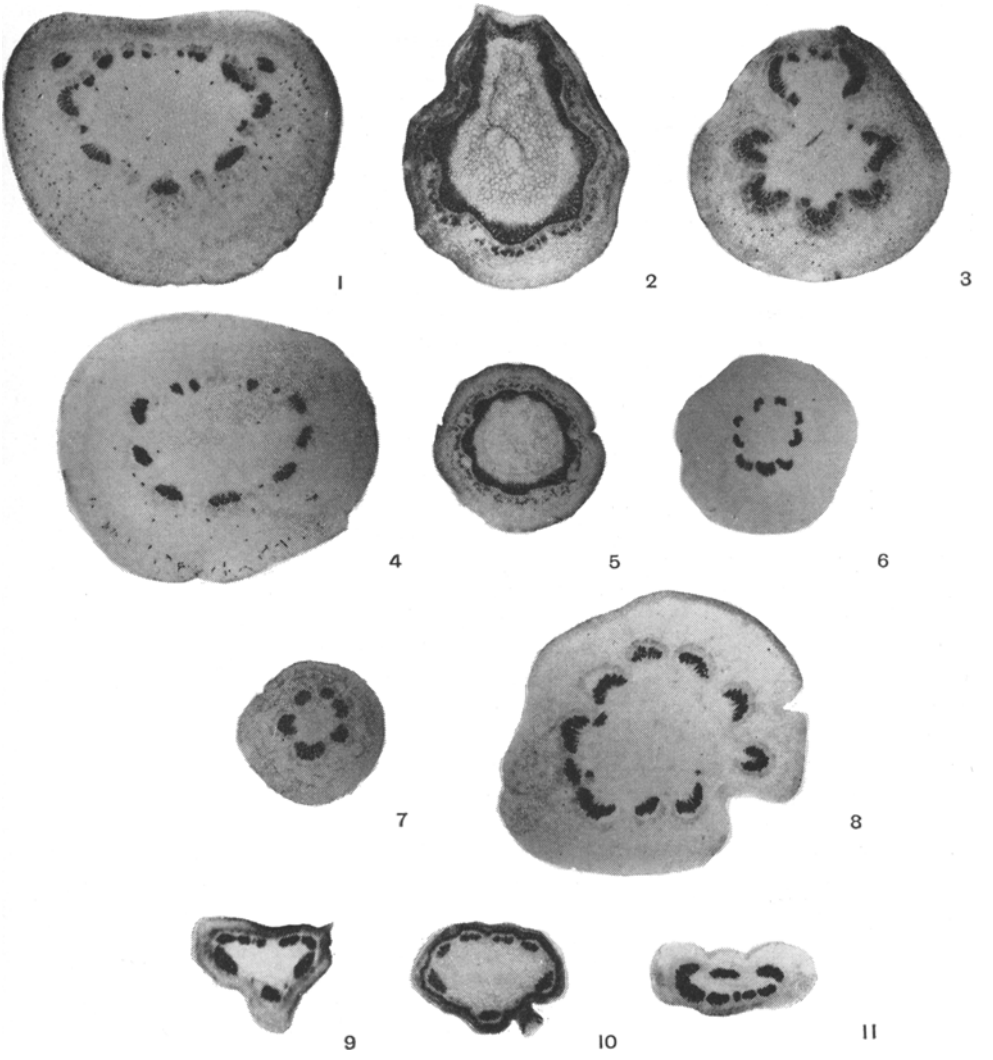


FIGS. 1–11. Petiole sections of *Jatropha* and *Cnidoscolus*, ×10. FIGS. 1–3. *Jatropha gossypifolia*: Basal, mid-, and distal sections. (*Webster et al. 9207*). FIGS. 4–6. *J. curcas*: Basal, mid-, and distal sections (*Miller 591*). FIG. 7. *J. hernandiaefolia*: Distal section (*Webster et al. 8830*). FIG. 8. *J. podagrica*: Distal section (*Karling s.n.*). FIGS. 9–11. *Cnidoscolus texanus*: Basal, mid-, and distal sections (*Webster & Webster 11103*).

wardly convex, in contrast to their nearly plane outline at the base of the petiole. As may be seen in Table 1, the commonest number of petiolar traces is either 6 or 9, and this is found in representatives of all four sections as interpreted by McVaugh. There is some variability in this respect, as *J. hastata* (= *J. integerrima*) usually has 6, but may also have 9. In *J. podagrica* the number varies from 9 to 11. The most aberrant species is perhaps *J. gossypifolia,* in which there are 2 supernumerary traces outside of the usual ring of 9 at the base of the petiole. All 11 traces merge into a siphonostele in mid-petiole, but at the distal end separate into 2 large adaxial and 5 smaller abaxial traces. The peculiar configuration at mid-petiole and the distal end appears to be correlated

with the adaxial prolongation of the petiole, as seen in cross-section. In all species of *Jatropha* that we have examined, phloem fibers are present in very limited numbers.

A cross-section of the petiole of *Cnidoscolus* (Figs. 9–11) shows usually 7 petiolar traces arranged in an ellipse; these remain separate from the base of the petiole to its junction with the lamina. The bundles do not become as pronouncedly convex-concave distally as in *Jatropha*. The dense and conspicuous ring of phloem fibers in the mid-petiole of *Cnidoscolus* has no counterpart in *Jatropha*. Crystals were not present in the petiole of either species of *Cnidoscolus* (and in fact appeared to be entirely absent from the leaves of *C. texanus*), but they were also lacking in several species of *Jatropha*. The rather erratic occurrence of crystals in the leaf tissue of both genera suggests that this morphological feature is at best of very limited taxonomic value.

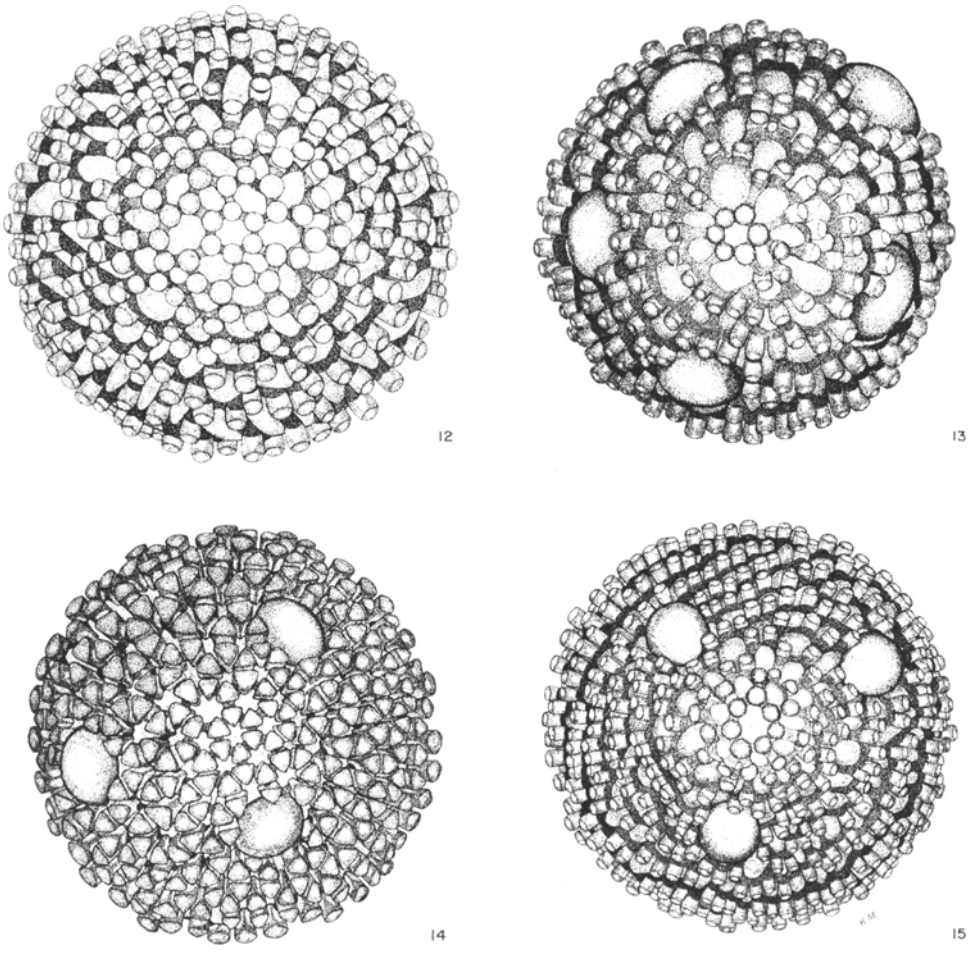
Pollen grain morphology of 5 species of *Cnidoscolus* and 11 species of *Jatropha* was studied from herbarium material and also from fresh material mounted in glycerine jelly according to the method of Wodehouse (1935). In order to ascertain the number of apertures, various microspores were observed while floating free in a small amount of lactic acid. Agitation of the medium with the tip of a dissecting needle was sufficient to cause the grains to rotate and make all sides clearly visible.

The microspores of *Cnidoscolus* and *Jatropha* resemble many of those in the tribe Jatropheae in their large size (diameter 50–90μ) and in their "Croton-pattern" of exine ornamentation as defined by Erdtman (1952). The characteristic appearance of such grains is due to conspicuous excrescences (verrucae) which are arranged in a regular polygonal or circular pattern around depressions or foramina. The verrucae are often laterally connected by, or project from, a ridge which bounds the depressions.

As Table 1 indicates, the pollen grains of *Cnidoscolus* and *Jatropha* are similar in size and sculpturing; in both genera the verrucae may be either round or triangular in cross-section. However, the grains of *Jatropha* (Fig. 12) are invariably non-aperturate, as reported by Erdtman, whereas those of *Cnidoscolus* (Figs. 13–15) are either 6-forate (in 3 species) or 10-forate (in *C. stimulosus*). The microspores of *Cnidoscolus* could also be described as 3-diploforate or 5-diploforate, since the foramina on each hemisphere are arranged in a triangular or pentagonal pattern which is superposed to that on the other hemisphere. This difference in pollen morphology was not reported by Erdtman, who did not mention any species of *Cnidoscolus*.

According to the interpretations of pollen morphology stated by Erdtman and Wodehouse, the pollen grains of *Cnidoscolus* should be less specialized than the non-aperturate ones of *Jatropha*. In a manner analogous to that suggested for the Chenopodiaceae by Wodehouse (1935), the foraminate microspore of *Cnidoscolus* may have been derived from a colporate one through shortening of the colpi. It would then represent an interesting transitional stage between typical tricolporate grains of other Crotonoideae such as *Acalypha* and *Euphorbia,* and the 'crotonoid' grains of *Jatropha*.

Observations of chromosome number were made from mitotic metaphases in young leaves according to the maceration aceto-carmine technique of Baldwin (1939). Best results were obtained by collecting material a little before noon on a sunny day, fixing it in Carnoy's fluid for 5 minutes, removing to a mixture of HCl and 95% ethanol (1:1) for 1 minute, and then returning to Carnoy's. After squashing, slides could be kept for approximately 3 days if the cover glass



FIGS. 12–15. Polar views of pollen grains of *Jatropha* and *Cnidoscolus*, ×320. FIG. 12. *J. curcas* (*Jiménez s.n.*). FIG. 13. *Cnidoscolus stimulosus* (*Miller 583*). FIG. 14. *C. tubulosus* (*Conzatti 5242*). FIG. 15. *C. urens* (*Asplund 960*).

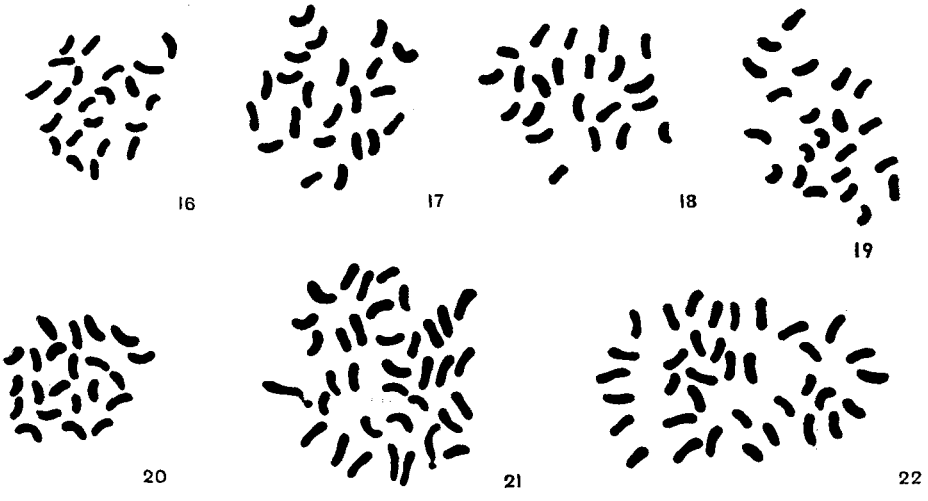
was ringed with rubber cement. Voucher specimens for all counts have been deposited in the Purdue University Herbarium (PUL).

Of the 5 species of Jatropha investigated, all proved to have $2n=22$ and are therefore diploids with $x=11$ (Figs. 16–20). Three of the counts represent confirmation of the reports of Perry (1943), whereas the counts of *J. hastata* and *J. hernandiaefolia* are new. The report of $n=11$ in *J. hastata* (= *J. integerrima*) is the first from sect. *Polymorphae*, and suggests that the base chromosome number is probably the same throughout the American taxa of the genus. The chromosomes are morphologically indistinguishable in all 5 species of *Jatropha* and have median centromeres.

In both of the species of *Cnidoscolus* that we studied (Figs. 21–22) a diploid number of 36 was found; these are thus apparently tetraploids on a base of $x=9$. These are the first reports of chromosome number in *Cnidoscolus* and are especially interesting in showing that the haploid number ($n=18$) is clearly different from that in *Jatropha*. The chromosomes of *Cnidoscolus* are somewhat

TABLE 1. Comparison of selected species of *Jatropha* and *Cnidoscolus*.

Taxon	Petiole traces	Pollen grains: mean diameter (μ)	Pollen grains: openings	Pollen grains: verrucae	Chromosome no. ($2n$)	Reference for chromosome no.
JATROPHA						
Sect. *Polymorphae*						
J. angustifolia		74	0	triang.		
J. integerrima	6(9)	73	0	round	22	Miller 1961
J. tupifolia	6	77	0	triang.		
Sect. *Macranthae*						
J. podagrica	9–11	87	0	round		
J. multifida	9	84	0	triang.	22	Perry 1943; Miller 1961
J. cathartica	9	77	0	triang.		
Sect. *Jatropha*						
J. gossypifolia	9+2	84	0	round	22	Perry 1943; Miller 1961
Sect. *Mozinna*						
subsect. *Eucurcas*						
J. curcas	9	77	0	round	22	Perry 1943; Miller 1961
subsect. *Mozinna*						
J hernandiaefolia	6	59	0	round	22	Miller 1961
J. divaricata	6	54	0	triang.		
J. dioica		76	0	triang.		
CNIDOSCOLUS						
Sect. *Jussieuia*						
Subsect. *Urentes*						
C. stimulosus	7	65	(8) 10	round	36	Miller 1961
C. texanus	7	66	(8) 10	r-tr.	36	Miller 1961
C. urens		68	6	r (tr)		
Sect. *Calyptrosolen*						
C. angustidens		62	6	triang.		
C. tubulosus		70	6	triang.		



FIGS. 16–22. Mitotic chromosomes of *Jatropha* and *Cnidoscolus*, ×725. FIG. 16. *Jatropha multifida*. FIG. 17. *J. hastata*. FIG. 18. *J. curcas*. FIG. 19. *J. hernandiaefolia*. FIG. 20. *J. gossypifolia*. FIG. 21. *Cnidoscolus stimulosus*. FIG. 22. *C. texanus*.

larger than those of *Jatropha,* and in *C. stimulosus* there is one satellited pair.

DISCUSSION

The results of our investigations definitely appear to confirm the suggestion of McVaugh that *Cnidoscolus* and *Jatropha* are very distinct genera. *Cnidoscolus* has a base chromosome number of $x=9$, foraminate pollen grains, and distinct petiolar traces, whereas *Jatropha* has a base number of $x=11$, non-aperturate pollen grains, and medially fused petiolar traces. Taken in conjunction with the many features cited by McVaugh (1944), this divergence of characteristics suggests that the two genera may in fact not be very closely related (as McVaugh, personal communication, has suggested). It would be premature to reassign *Cnidoscolus* to a completely new position within the Crotonoideae, but it may be significant that *Cnidoscolus* shows many more similarities with *Manihot* than it does with *Jatropha.* In *Manihot,* as in *Cnidoscolus,* there is only a single floral envelope, and in both genera the base chromosome number appears to be $x=9$. Furthermore, the polyforate microspores of *Manihot* are more similar to those of *Cnidoscolus* than are the non-aperturate ones of *Jatropha.* As Erdtman has noted, the palynological and cytological evidence suggests that *Jatropha* is closer to such genera as *Aleurites.* Pax (1910) appears to have been closer to the facts in grouping these two genera in the subtribe Jatrophinae than were Pax and Hoffmann (1931) in placing them in widely separated tribes (Cluytieae and Crozophoreae).

The present investigations are also of interest in connection with the problem of the generic integrity of *Jatropha.* Since at least one species from each of the four American sections (*Polymorphae, Macranthae, Jatropha,* and *Mozinna*) was studied, a fairly good indication of the intrageneric diversity of the genus was obtained. It is notable that *J. curcas,* which has been made the type of a segregate genus *Curcas,* has the same chromosome number ($n=11$), the typical number of petiolar traces (9), and 'crotonoid' pollen grains nearly indistinguishable from those of *J. gossypifolia* and other species. The similarity in chromosome number and pollen morphology among representatives of the four sections is striking, and the diversity of petiolar trace number is correlated with sectional lines. More extensive study of petiolar anatomy and other morphological characteristics may possibly provide useful evidence in further delimiting intrageneric taxa. The evidence presented here, however, strongly favors the conservative interpretation that taxa such as *Curcas* and *Mozinna* are best treated as sections or subgenera within *Jatropha.*

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TAXONOMIC NOTES ON MYXOMYCETES, IV[1]

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1. THREE NEW SPECIES

Many published names of Myxomycetes are based on specimens known only from the type collection. A fair number of these names are still recognized as referring to distinct species, some with little or no doubt, others with varying degrees of uncertainty. The majority of these names have found their way into synonymy, again in most cases with little doubt but continuing uncertainty in others. It is, therefore, incumbent upon those who describe new taxa upon such a restricted basis to take every precaution to avoid giving a new name to a collection which does not seem to fit into any recognized species, until the literature has been carefully reviewed and until the author seems to have eliminated the possibility that it may represent an unusual variation of a known species.

Such specimens do exist, and they must be taken into account. Some species, after the original description has brought them to attention, are collected later and may prove to be not uncommon. The case of *Echinostelium minutum* is an excellent example. Originally described by de Bary on the basis of laboratory developments and published under his name by Rostafiniski in 1874, it was for some years known only from the original description and even longer regarded as a rarity. It is now known to be extremely common wherever it has been sought and will probably prove to be of cosmopolitan distribution. A number of comparable cases may be cited.

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