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American Journal of Botany, Vol. 67, No. 4. (Apr., 1980), pp. 595-602.

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CHROMOSOME NUMBERS IN THE PHASEOLEAE (FABACEAE:FABOIDEAE) AND THEIR RELATION TO TAXONOMY¹

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A B S T R A C T

Chromosome numbers are reported for 33 species of the tribe Phaseoleae. Six reports are first counts for their species; one report (*Ophrestia hedyaroides*) is a first count for the genus. This increases the number of genera counted to 53 out of a total 84 for the tribe. A survey of base numbers shows a general pattern of numbers 10 or 11, the same base numbers as in the neighboring tribes Dalbergieae *sensu lato*, Galegeae *sensu lato*, and Abreae. The chromosomes are generally small and polyploidy is uncommon. Deviations from base numbers 10 or 11 are mostly found in those genera with morphological peculiarities and puzzling taxonomic placements: *Erythrina* (21), *Clitoria* (8, 11, 12), *Butea* (9), *Calopogonium* (18), *Teramnus* (14), and *Strongylodon* (14). Two genera have base numbers which suggest derivation by polyploidy: *Glycine* (20) and *Cologania* (22).

PREVIOUS CHROMOSOME COMPENDIA of the tribe Phaseoleae were part of chromosome studies of the entire Fabaceae (Atchison, 1951; Bandel, 1974; Freckman and Wemple, 1963; Turner and Fearing, 1959; Senn, 1938). These studies were effective in revealing chromosome lines at the tribal level and above, but they devoted understandably little attention within the Phaseoleae. Also, the recent and complete restructuring of included subtribes, creation of new genera and generic descriptions, and reassignment of species to different genera based on studies of morphology, biochemistry, seedling structure, palynology, and leaflet anatomy (Baudet, 1978; Lackey, 1977a, 1977b, 1977c, 1978a, 1978b, 1978c, 1979a, 1979b, 1979c; Maréchal, Mascherpa, and Stainier, 1978; Verdcourt, 1970, 1971, 1978) require reordering the legion of chromosome counts reported under old systems into the new system. The present paper includes some new chromosome counts in the Phaseoleae, a tabulation of chromosome base numbers for genera in the tribe, and an analysis of the comparability of these data with the new classification.

MATERIALS AND METHODS—Chromosome counts from the literature were compiled from the listings of Cave (1956–1964), Darlington

and Wylie (1956), Federov (1969), Moore (1973), recent reports in the journal *Taxon*, Goldblatt and Davidse (1977), and a general review of taxonomic literature in the Phaseoleae (Lackey, 1979d). Peter Goldblatt (personal communication) furnished some of his unpublished counts.

New counts are based on study of mitosis in root tips by the method of Palmer and Heer (1973) for soybeans (*Glycine max*). This is a modified squash technique involving pretreatment by paradichlorobenzene (PDB), staining with Feulgen's stain, and middle lamella weakening with pectinase. The preparations were observed and photographed with a Zeiss WL research microscope equipped with a Nikon camera.

Because of the variety of plant materials for many species, it was difficult to obtain sufficient numbers of countable metaphase stages to insure accurate counts. Most seeds germinated more slowly than *Glycine max* (one *Kenedia* took three months to germinate); consequently, root tips generally were cut at a later day than given by Palmer and Heer (1973). Different pretreatments than PDB were tried: monobromonaphthalene (MBN), and 8-hydroxyquinoline (OQ). They were no more successful at producing acceptable preparations than PDB. Of the 250 samples taken for chromosome counts, about 40 gave adequate preparations.

RESULTS AND DISCUSSION—Some photographs are given in Fig. 1–11 of chromosomes observed in the present study (Table 1). These new counts are added to previous counts for the generic review in Table 2, which is arranged

¹ Received for publication 19 July 1979; revision accepted 9 October 1979.

This paper is part of a Ph.D. dissertation research. Reid Palmer, Hollys Heer, Duane Isely, and Harold Robinson gave advice on the research and presentation. The curators and keepers of herbaria at Missouri Botanical Garden (MO), Royal Botanic Gardens, Kew (K), and Iowa State University (ISC), allowed use of their specimens.

TABLE 1. *Chromosome counts in Phaseoleae from present study*

Species ^a	Sporophytic count	Voucher or source ^b
Cajaninae Benth		
<i>Cajanus kerstingii</i> Harms*	22	Enti & Hall GC35999 (K)
<i>Flemingia grahamiana</i> Arnott*	22	PI 247850
<i>Rhynchosia phaseoloides</i> (Swartz) A. P. de Candolle	22	Lackey 200 (ISC)
<i>Rhynchosia reticulata</i> (Swartz) A. P. de Candolle*	22	Croat 14100 (MO)
Diocleinae Benth		
<i>Pachyrhizus tuberosus</i> (Lamarck) Sprengel	22	Lackey 127, 164, 199 (ISC)
<i>Calopogonium mucunoides</i> Desvaux	ca. 37	Lackey 143 (ISC)
<i>Calopogonium</i> sp.	36	PI 234875
Kennediinae Benth		
<i>Kennedia coccinea</i> Ventenat*	22	King's Park, Perth 2830
<i>Kennedia retrorsa</i> Hemsley*	22	Roy. Bot. Gard., Sydney
<i>Kennedia rubricunda</i> (Curtis) Ventenat	22	Roy. Bot. Gard., Sydney
<i>Hardenbergia violacea</i> (Schneevoogt) Stearn	22	CSIRO C1152
Phaseolinae Benth		
<i>Psophocarpus palustris</i> Desvaux	ca. 18	Breteler 12383 (K)
<i>Psophocarpus tetragonolobus</i> (Linnaeus) A. P. de Candolle	ca. 18	commercial source
<i>Lablab purpureus</i> (Linnaeus) Sweet	22	Lackey 118 (ISC)
<i>Lablab purpureus</i> (Linnaeus) Sweet	22	PI 280861
<i>Lablab purpureus</i> (Linnaeus) Sweet	22	PI 212998
<i>Dipogon lignosus</i> (Linnaeus) Verdcourt	22	PI 330601
<i>Macrotyloma uniflorum</i> (Lamarck) Verdcourt	20	PI 196290
<i>Macrotyloma uniflorum</i> (Lamarck) Verdcourt	20	PI 165901
<i>Vigna angularis</i> (Willdenow) Ohwi & Ohashi	22	PI 196174
<i>Vigna luteola</i> (Jacquin) Benth	22	Lye 3632 (K)
<i>Vigna oblongifolia</i> A. Richard	22	Boonman KL77K53342 (K)
<i>Vigna radiata</i> (Linnaeus) Wilczek	ca. 22	PI 70253
<i>Voandzeia subterranea</i> (Linnaeus) Thouars ^c	22	Hepper 2703 (K)
<i>Strophostyles helvula</i> (Linnaeus) Elliott	22	Lackey 160, 195 (K)
Clitoriinae Benth		
<i>Clitoria laurifolia</i> Poiret	24	PI 322358
<i>Clitoria rubiginosa</i> Persoon	22	Lackey 145 (ISC)
<i>Clitoria ternatea</i> Linnaeus	16	Lackey 135, 157, 169, 178 (ISC)
Glycininae Benth		
<i>Glycine clandestina</i> Willdenow	ca. 40	PI 248252
<i>Glycine gracilis</i> Skvortzow	40	PI 135590
<i>Glycine tabacina</i> (Labillardiere) Benth	ca. 80	PI 321391
<i>Glycine tabacina</i> (Labillardiere) Benth	ca. 40	Lackey 155 (ISC)
<i>Teramnus uncinatus</i> (Linnaeus) Swartz	ca. 28	PI 213514
<i>Neonotonia wightii</i> (Arnott) Lackey	22	PI 279116
<i>Neonotonia wightii</i> (Arnott) Lackey	22	PI 339666
<i>Neonotonia</i> sp. A ^d *	22	Peter 43348 (K)
Ophrestiinae Lackey		
<i>Ophrestia hedysaroides</i> (Willdenow) Verdcourt**	20	PI 274229
Erythrinae Benth		
<i>Mucuna pruriens</i> (Linnaeus) A. P. de Candolle	22	Lackey 148, 161 (ISC)
genus referred to tribe Galegeae		
<i>Wisteria frutescens</i> (Linnaeus) Poiret	16	New York Bot. Gard. 418

^a Species are listed by subtribe (Lackey, 1979c). A single asterisk following a species name indicates a first count for the species; a double asterisk indicates a first count for the genus.

^b Vouchers are listed by herbarium code (Stafleu, 1974), collector, and number. Seeds bearing USDA plant introduction numbers are listed by PI numbers. Seeds from botanic gardens are listed by institution name and identification. Seeds from the Commonwealth Scientific and Industrial Research Organization are listed by their (CSIRO) numbers.

^c *Voandzeia* is congeneric with *Vigna* (Marechal et al., 1978). Verdcourt (1978) has proposed conservation of *Vigna*. Until his proposal is accepted, there will be no correct name for this species under *Vigna*.

^d Called *Glycine* sp. A by Verdcourt (1971).

according to the classification of Lackey (1979c).

Many of the chromosome counts of angiosperms reported in the literature are incorrect (Davis and Heywood, 1963; Raven, 1975). The Phaseoleae are no exception. Aside from misidentification and synonymy difficulties, inaccurate counts are fairly frequent, especially in papers which contain listings for many families. All reports made prior to 1920 were made from sectioned material, which is subject to difficulties in interpretation. It was therefore necessary in this study to make some assessment of the probable validity of many reported chromosome counts by comparison with other reports and considering the apparent rigor of the individual study.

General considerations—Chromosome counts for the Phaseoleae follow a very consistent pattern: with the exception of *Oxyrhynchus*, all genera which on morphological grounds are placed in the tribe without reservation have credible chromosome counts with base numbers (x) of 10 or 11 (in *Glycine*, $x = 20$ and in *Cologania*, $x = 22$, but these obviously are stabilized polyploids). Base numbers 10 and 11 are the same as in many Dalbergieae *sensu lato*, Galegeae *sensu lato*, and Abreae (Freckman and Wemple, 1963; Turner and Fearing, 1959), with which the Phaseoleae are generally related. Tischler (1935) noted the scarcity of polyploids in the Phaseoleae, and my current review and observations confirm this. Most chromosomes of the tribe are small (Faris, 1964; Fearing, 1959); the extreme example is *Macrotyloma* with chromosomes as small as $0.97 \mu\text{m}$ at mitosis (Maréchal and Otoul, 1966). However, suspensor cells of *Phaseolus* are highly endopolyploid and exhibit huge banded chromosomes which can be analyzed in detailed fashion (Schweizer, 1976).

Setting aside some doubtful counts for future consideration, there remain some exceptional and credible counts which require comment. These counts involve genera having significant morphological peculiarities. *Butea* and *Calopogonium* seem to have base numbers of 9 and 18 (sporophytic counts² of 18 for *Butea* and 36 for *Calopogonium*). For both genera it is reasonable to hypothesize a mechanism of derivation of these numbers from ancestors with chromosome base number 11 or 10 by aneuploid loss, but they are probably derived from different ancestors. *Butea* perhaps has closer allies in the Dalbergieae *sensu lato* or Galegeae *sensu lato*, so that any accurate assessment

of its chromosomal alliances is futile at this point. *Calopogonium* is placed in the Phaseoleae only with question; its closest true allies are unknown. *Erythrina* consistently has base number 21, unique for the Phaseoleae, which may be a legacy from an ancient allotetraploid derived from plants with counts of 22 and 20 (Freckman and Wemple, 1963). This unique chromosome base number correlates with many other odd attributes of *Erythrina* (Lackey, 1977b). *Teramnus* is anomalous in the subtribe Glycininae on morphological and phytogeographical considerations. The chromosome counts, usually 28, reinforce this. *Strongylodon*, a peculiar member of the subtribe Erythrinae, also has chromosome counts of 28. *Clitoria* has counts of 24, 22, and 16, which are difficult to harmonize in one genus. It also is difficult to reconcile these counts with counts of 20 and 22 for other members of the subtribe Clitoriinae. Perhaps this subtribe has nearest alliances outside the tribe Phaseoleae. Such a puzzling assortment of chromosome numbers can only be understood in relation to a larger complex of possible allies.

Oxyrhynchus has been recently counted at 24 (Peter Goldblatt, personal communication). This is a departure from most allies in the subtribe Phaseolinae, which have counts of 20 or 22. Neither the taxonomic placement of *Oxyrhynchus*, nor the validity of the count is open to serious question. The additional chromosome pair of *Oxyrhynchus* can be most easily explained by aneuploid gain.

Aside from the credible counts of 24 somatic chromosomes in *Clitoria* and *Oxyrhynchus*, mentioned above, there have been incorrect counts of 24 in many genera of the Phaseoleae. Němec (1910) began the list with counts of 24 for species of *Dioclea*, *Dolichos*, and *Phaseolus*. The generic list was expanded, primarily during the next two decades, to include counts of 24 in *Rhynchosia*, *Vigna*, *Lablab*, *Macrotyloma*, and *Pueraria*. The mistakes of early cytologists can be understood easily when one considers the tedious methods and interpretative problems which confronted them; most of these counts are solitary, and have been shown wrong by an accumulation of subsequent reports. However, in *Vigna*, acceptance of counts of 24 has been more persistent, causing Senn (1938) to propose chromosomal races of 22 and 24 for the cultivated *Vigna unguiculata*. Frahm-Leliveld (1965) reported *Vigna* species with some chromosome counts of 20, some of 22, and some of 24 in the same preparation. This variation is probably due to the many difficulties of producing good chromosome preparations, and is not due to natural variation in the species: Faris (1964) exhaus-

² Counts given in this paper will be assumed to be sporophytic (somatic) counts unless otherwise noted.

TABLE 2. *Distribution of chromosome numbers in the Phaseoleae*^a

Genus ^b	<i>x</i> = ^c	<i>n</i> = ^d
Cajaninae Bentham		
1. <i>Cajanus</i> A. P. de Candolle 2/2	11	11(9), 22(1), 33(1)
2. <i>Atylosia</i> Arnott 9/35	11	11(9)
3. <i>Dunbaria</i> Arnott 0/15		
4. <i>Bolusafra</i> Kuntze 1/1	11	11(1)
5. <i>Endomallus</i> Gagnepain 1/2		[8(1)]
6. <i>Baukea</i> Vatke 0/1		
7. <i>Flemingia</i> Aiton f. 5/30	11	[10(3)], 11(9)
8. <i>Chrysoscias</i> E. Meyer 0/6		
9. <i>Carissoa</i> E. G. Baker 0/1		
10. <i>Rhynchosia</i> Loureiro 22/250	11	11(38), [12(1)]
11. <i>Eriosema</i> (A. P. de Candolle) G. Don 8/130	11	11(10), [10(1)]
12. <i>Paracalyx</i> Ali 1/6	11	11(1)
13. <i>Adenodolichos</i> Harms 1/15	11	11(2)
Diocleinae Bentham		
14. <i>Dioclea</i> Humboldt, Bonpland, & Kunth 3/30	11	11(3), [12(1)]
15. <i>Cymbosema</i> Bentham 0/1		
16. <i>Cleobulia</i> Bentham 0/3		
17. <i>Canavalia</i> A. P. de Candolle 7/50	11	11(18), 22(2)
18. <i>Pachyrhizus</i> A. P. de Candolle 2/6	11	11(5)
19. <i>Macropsychnanthus</i> Harms 0/3		
20. <i>Luzonia</i> Elmer 0/1		
21. <i>Camptosema</i> Hooker & Arnott 2/12	11	11(2)
22. <i>Cratylia</i> Bentham 0/5		
23. <i>Collaea</i> A. P. de Candolle 1/3	10	10(1)
24. <i>Galactia</i> P. Browne 8/50	10	10(8), [11(1)]
25. <i>Calopogonium</i> Desvaux 1/8	18	18(4)
26. <i>Herpyza</i> Ch. Wright 0/1		
Kennediinae Bentham		
27. <i>Kennedia</i> Ventenat 4/15	11	11(6)
28. <i>Hardenbergia</i> Bentham 1/2	11	11(3)
29. <i>Vandasia</i> Domin 1/1	11	11(1)
Phaseolinae Bentham		
30. <i>Dysolobium</i> (Bentham) Prain 0/4		
31. <i>Psophocarpus</i> A. P. de Candolle 2/10	9?	[9(1), 10(2), 11(1), 13(1)]
32. <i>Physostigma</i> J. H. Balfour 1/4	11	11(2)
33. <i>Vatovaea</i> Chiovenda 0/1		
34. <i>Decorsea</i> Viguier 0/4		
35. <i>Spathionema</i> Taubert 0/1		
36. <i>Otoptera</i> A. P. de Candolle 0/2		
37. <i>Sphenostylis</i> E. Meyer 3/7	11	11(1), [9(1), 10(1)]
38. <i>Nesphostylis</i> Verdcourt 0/2		
39. <i>Austrodolichos</i> Verdcourt 0/1		
40. <i>Neorautanenia</i> Schinz 1/3	11	11(1)
41. <i>Lablab</i> Adanson f. 1/1	11	11(9), [10(2), 12(3)]
42. <i>Alistilus</i> N. E. Brown 0/2		
43. <i>Dipogon</i> Liebmann 1/1	11	11(4)
44. <i>Dolichos</i> Linnaeus 4/60	10	10(5), [12(1)]
45. <i>Macrotyloma</i> (Arnott) Verdcourt 7/24	10	10(15), [11(3), 12(1)]
46. <i>Vigna</i> Savi 36/150	10, 11	10(22), 11(115), 22(6), [12(10)]
47. <i>Ramirezella</i> Rose 0/8		
48. <i>Oxyrhynchus</i> Brandege 1/3	12	12(1)
49. <i>Dolichopsis</i> Hassler 0/2		
50. <i>Strophostyles</i> S. Elliott 2/3	11	11(3)
51. <i>Macroptilium</i> (Bentham) Urban 5/20	11	11(13)
52. <i>Phaseolus</i> Linnaeus 17/50	10, 11	10(1), 11(57), 22(1), [12(1)]
Clitoriinae Bentham		
53. <i>Centrosema</i> Bentham 5/45		[10(4), 11(1), 9(1), 12(1)]
54. <i>Periandra</i> Bentham 2/7	11	11(3)
55. <i>Clitoria</i> Linnaeus 4/70	8, 10, 12	8(6), 11(1), 12(3)
56. <i>Clitoriopsis</i> Wilczek 0/1		

TABLE 2. *Continued*

Genus ^b	$x = ^c$	$n = ^d$
Glycininae Benth		
57. <i>Eminia</i> Taubert 1/5	11	11(1)
58. <i>Pseudeminia</i> Verdcourt 0/4		
59. <i>Pseudovigna</i> Verdcourt 1/1	11	11(2)
60. <i>Pueraria</i> A. P. de Candolle 4/25	11	11(9), [10(2), 12(3)]
61. <i>Nogra</i> Merrill 1/3	11	11(1)
62. <i>Sinodolichos</i> Verdcourt 0/2		
63. <i>Glycine</i> Willdenow 8/8	20	20(31), 40(4), [19(3)]
64. <i>Teramnus</i> P. Browne 3/8	14	14(3), [10(1)]
65. <i>Diphyllarium</i> Gagnepain 0/1		
66. <i>Mastersia</i> Benth 0/2		
67. <i>Teyleria</i> Backer 0/1		
68. <i>Neonotonia</i> Lackey 2/2	11	11(5), 22(3), [20(3), 10(1)]
69. <i>Shuteria</i> Arnott 1/5	11	11(1)
70. <i>Dumasia</i> A. P. de Candolle 3/8	11	11(2), [10(2)]
71. <i>Cologania</i> Kunth 3/10	22	22(3)
72. <i>Amphicarpa</i> Nuttall 2/3	10	10(3), 20(2), [11(2)]
Ophrestiinae Lackey		
73. <i>Ophrestia</i> H. M. L. Forbes 1/12	10	10(1)
74. <i>Pseudoeriosema</i> Hauman 1/6	11	11(2)
75. <i>Cruddasia</i> Prain 0/1		
Erythrinae Benth		
76. <i>Erythrina</i> Linnaeus 65/108	21	21(117), 42(5), 126?(2), [16(1), 20(1), 22(2)]
77. <i>Strongylodon</i> Nogk 1/20	14	14(1)
78. <i>Mucuna</i> Adanson 4/100	11	11(13), 22(2), [20(1)]
79. <i>Butea</i> Willdenow 1/4	9	9(7)
80. <i>Spatholobus</i> Hasskarl 0/15		
81. <i>Apios</i> Fabricius 1/10	11	11(2), 16½(1), [20(1)]
82. <i>Cochlianthus</i> Benth 0/2		
83. <i>Rhodopis</i> Urban 0/1		
84. <i>Neorudolphia</i> Britton 0/1		

^a Chromosome counts were compiled from the present research, the listing given by Lackey (1979d) for counts before 1977, a review of recent literature, and personal communication with Peter Goldblatt.

^b Genera are listed by subtribe in the order given by Lackey (1979c). Numbers immediately following genera indicate the number of species counted and the total number of species in the genus.

^c x = assumed base chromosome number for each genus by analysis of reported chromosome counts.

^d n = gametophyte chromosome counts from the literature with number of reports in parentheses. Sporophyte counts are converted to gametophyte counts. Doubtful counts are given in brackets.

tively studied 192 cultivars and strains of *Vigna unguiculata*, from which he concluded that previous counts of 24 and 20 were wrong.

Systematic review—Cajaninae—Virtually all counts of the Cajaninae are 22; polyploidy is rare. All anomalous reports are questionable: *Endomallus* (16), *Flemingia strobilifera*, *F. macrophylla*, and *F. lineata* (20), *Rhynchosia pycnostachya* (24), and *Eriosema edule* (20). Few important modifications to the internal classification of the Cajaninae are indicated by chromosomes: Kumar, Thonbre, and D'Cruz (1958) reported a close similarity in the chromosome complements of *Cajanus* and *Atylosia* and an ability to cross the two genera, and Frahm-Leliveld (1969) reported more variability in the karyotypes of *Rhynchosia* spp. than in *Eriosema* spp., which she attributed

to the greater age of *Rhynchosia*. The uniformity of chromosome base number stresses the internal unity of the subtribe, already apparent from other considerations.

Diocleinae—The subtribe mostly has counts of 22. Only one polyploid count of 44 is known. Némec (1910) counted 24 in *Dioclea boykinii*, but this is unconfirmed and doubtful. *Galactia* and *Collaea* consistently have counts of 20 (22 was reported once for *G. longifolia*, but this is probably incorrect), which makes them chromosomally distinct from the remainder of the subtribe. *Calopogonium* has a count of 36, which adds another character to set the genus apart from the remaining Diocleinae.

Kennediinae—The Kennediinae consistently have counts of 22. This is in line with the

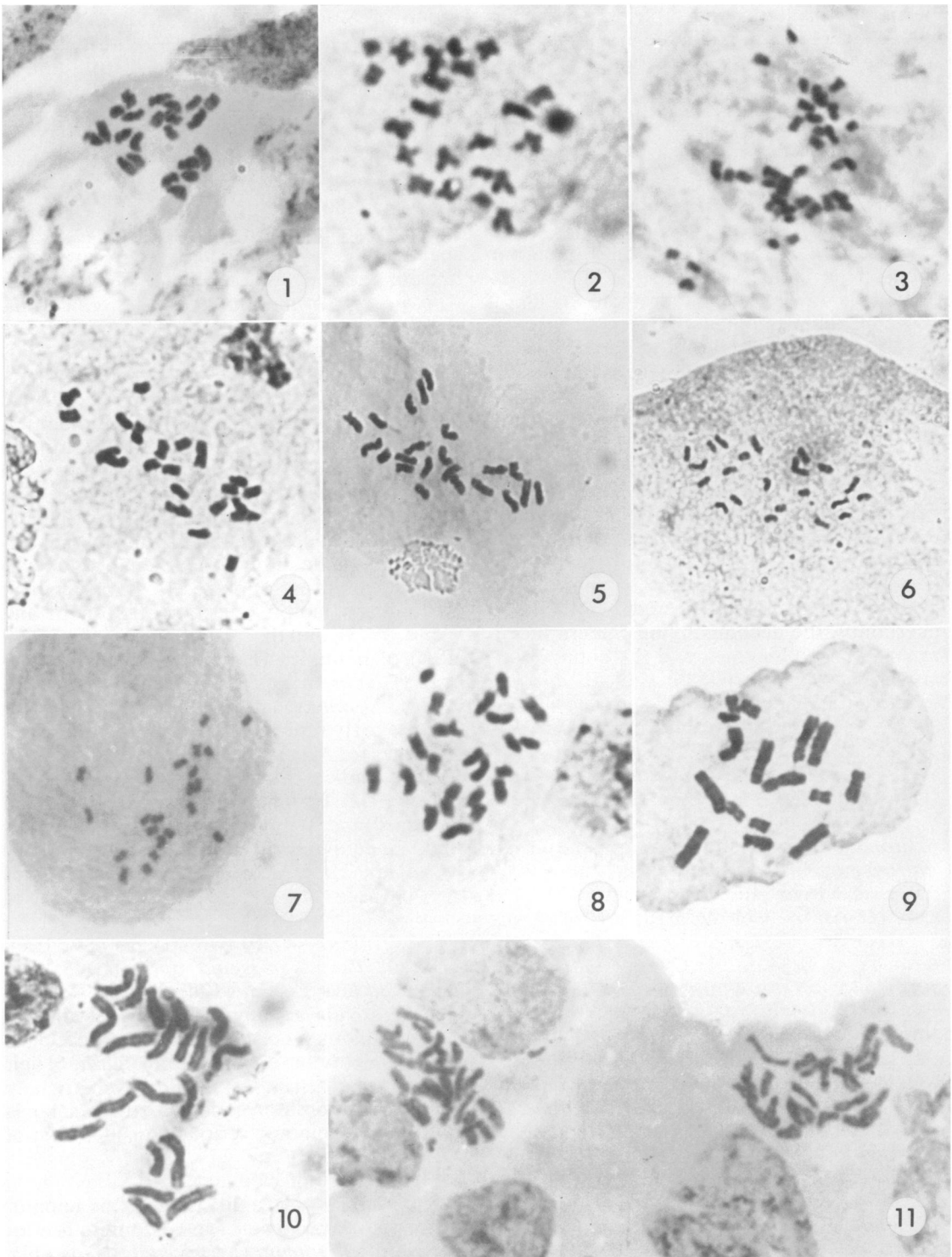


Fig. 1-11. Photographs of somatic chromosomes of Phaseoleae. 1. *Rhynchosia reticulata* (Swartz) A. P. de Candolle, $2n = 22$, from Croat 14100 (MO). $\times 940$. 2. *Pachyrhizus tuberosus* (Lamarck) Sprengel, $2n = 22$, from Lackey 127 (ISC). $\times 1570$. 3. *Calopogonium* sp., $2n = 36$, from PI 234875. $\times 1190$. 4. *Kennedia rubricunda* (Curtis) Ventenat, $2n = 22$, from seed Roy. Bot. Gard. Sydney, $\times 1690$. 5. *Hardenbergia violacea* (Schneevoogt) Stearn, $2n = 22$, from seed CSIRO C1152. $\times 985$. 6. *Vigna angularis* (Willdenow) Ohwi & Ohashi, $2n = 22$, from PI 19674. $\times 950$. 7. *Voandzeia subterranea* (Linnaeus) Thouars, $2n = 22$, from Hepper 2703 (K). $\times 1545$. 8. *Clitoria rubiginosa* Persoon, $2n = 22$, from Lackey 145 (ISC). $\times 1520$. 9. *Clitoria ternata* Linnaeus, $2n = 16$, from Lackey 178 (ISC). $\times 1065$. 10. *Ophrestia hedysaroides* (Willdenow) Verdcourt, $2n = 20$, from PI 274229. $\times 1690$. 11. *Neonotonia* (*Glycine*) sp. A, $2n = 22$, from Peter 43348 (K). $\times 1340$.

internal uniformity of the subtribe, all species of which were once considered members of the single genus *Kennedia*.

Phaseolinae—The Phaseolinae are chromosomally and morphologically complex. All unquestioned members have counts of 20 or 22, or rarely (*Oxyrhynchus*) 24. *Vigna*, a large and unwieldy genus, has counts of 22 and sometimes 20. The scattered counts of 20 do not correlate with any general taxonomic groups in the genus (Verdcourt, 1970). *Macrotyloma* and *Dolichos* have credible counts of 20, which seem significant in view of the previous inclusion of *Macrotyloma* in *Dolichos*. The closely allied American genera *Phaseolus*, *Strophostyles*, and *Macroptilium* uniformly have counts of 22, with the exception of a count of 44 for *P. formosus* and a count of 20 for *P. anisotrichos*.

Only two species of *Psophocarpus* have been reported in the literature: *P. scandens* and *P. tetragonolobus*. For the former, counts of 20 and 22, and for the latter, 18 and 26 have been reported. The number 26 is probably wrong: the researcher (Ramirez, 1960) stated uncertainty, the accompanying camera lucida drawing was ambiguous, and the count is unknown elsewhere in the Phaseoleae. I could not make reliable counts of *Psophocarpus* because of clumping of chromosomes, but I believe 18 may be correct. This would place *Psophocarpus* in a chromosomally unique position in the subtribe.

Clitoriinae—The subtribe, consisting of *Centrosema*, *Clitoria*, *Periandra*, and *Clitoriopsis*, is chromosomally puzzling, although morphologically well-defined. *Clitoria* has counts of 16 (*C. ternatea*, enormous chromosomes in Fig. 9), 24 (*C. cordobensis*, *C. laurifolia*, and *C. rubiginosa*), and 22 (*C. rubiginosa*). It is difficult to reconcile these counts within the genus, or with the other counts in the subtribe such as *Periandra* (22), *Centrosema brasilianum* (24), *C. coriaceum* (22), *C. virginianum* (18), *C. spp.* (20). Probably some of these latter counts are incorrect: chromosomes of *Centrosema* tend to clump at mitosis, preventing reliable counts.

Glycininae—Nearly all Glycininae have somatic counts with base numbers 10 or 11. The only possible exceptions are two species of *Teramnus* counted at 28, and two counts of *Pueraria* spp. at 24. The *Teramnus* counts are possibly correct; the *Pueraria* counts are contradicted by other reports and probably wrong, and Frahm-Leliveld (1957) admitted that one of them, her earlier count of 24, was wrong.

Chromosome counts for the small natural

group of *Shuteria*, *Amphicarpa*, *Cologania*, and *Dumasia* help only slightly in classification. Counts reflect an erratic distribution of base numbers 10 and 11, but counts for *Cologania* (44) are distinct from *Amphicarpa* (20 or 40), *Dumasia* (20? or 22), and *Shuteria* (22).

The chromosome counts of the genus *Glycine* are well known. All species have 40 or sometimes 80 somatic chromosomes. This is the only instance in the Phaseoleae where species have somatic counts of 40 or 80 but not 20; the only other reports of 40 are for *Amphicarpa bracteata* and *A. edgeworthii*, and these species have also been reported with 20 chromosomes. Considering the other counts in the tribe and subtribe, the unique chromosome number of *Glycine* is probably derived from diploid ancestors with base number 11, which have undergone aneuploid loss to base number 10 and subsequent polyploidy to give somatic counts of 40 or sometimes 80. The species could then be regarded as originally tetraploids which now function as diploids because of modification of their genetic makeup. This viewpoint is supported by the frequency of duplicate factor inheritance (Bernard and Weiss, 1973), and the lack of much detrimental effect of trisomics (Palmer, 1976) in the soybean (*Glycine max*). Until recently (Lackey, 1977c), *Neonotonia* was included in *Glycine*. Despite early reports of 20 or 40 somatic chromosomes for *Neonotonia*, the studies of Cheng (1963), Hadley and Hymowitz (1973), Pritchard (1972), Pritchard and Gould (1964), and Pritchard and Wutoh (1963), and the present study unequivocally confirm counts of 22 or 44 and the larger size of these chromosomes than those in *Glycine*.

Ophrestiinae—Only two species have been counted: *Pseudoeriosema borianii* (22) and *Ophrestia hedyaroides* (20). Pritchard (1972) suggested from a study of karyotypes that *P. borianii* shares a common ancestry and close relationship with *Neonotonia wightii*. Their chromosome attributes may be superficially similar, but their morphological relationship is too distant to permit serious consideration of this suggestion.

Erythrinae—As expected for this unnatural group, chromosome base numbers are inconsistent: *Erythrina* (21), *Strongylodon* (14), *Butea* (9), *Mucuna* (11), and *Apios* (11?).

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