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Cytogenetic studies in some representatives of the subfamily Pooideae (Poaceae) in South Africa. 3. The tribe Poeae

J.J. SPIES*, S.M.C. VAN WYK*, I.C. NIEMAN* and E.J.L. LIEBENBERG**

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ABSTRACT

This is a report on chromosome numbers for the tribe Poeae, which is represented in South Africa mainly by naturalized exotics. Chromosome numbers of 67 specimens, representing 26 species and 11 genera, are presented. These numbers include the first reports on *Poa binata* Nees (n = 3x = 21 and n = 4x = 28), *Puccinellia acroxantha* C.A.Sm. & C.E.Hubb. (n = 3x = 21) and *P. angusta* (Nees) C.A.Sm. & C.E.Hubb. (n = x = 7). New ploidy levels are reported for *Catapodium rigidum* (L.) C.E.Hubb. (n = 2x = 14), *Festuca caprina* Nees (n = 2x = 14) and *F. scabra* Vahl (n = x = 7).

INTRODUCTION

The first paper in this series indicated the importance of determining the ploidy levels and basic chromosome numbers of naturalized and endemic flora in South Africa (Spies *et al.* 1996a). In the second paper chromosome numbers of the rest of the tribe Aveninae were presented (Spies *et al.* 1996b). This third paper in the series on chromosome numbers of representatives of the subfamily Pooideae in South Africa, is restricted to the tribe Poeae.

During this study we followed the classification system of Gibbs Russell *et al.* (1990) for the tribal separation. Therefore we did not recognize the tribe Hainardeae Greuter, and all the species usually belonging to this small tribe are included in the Poeae. The tribe Poeae consists, therefore, of approximately 55 genera and more than 5000 species (Clayton & Renvoize 1986). Most local species belonging to this tribe are naturalized exotics. The Poeae are represented in South Africa by the genera *Briza* L., *Catapodium* Link, *Colpodium* Trin., *Cynosurus* L., *Dactylis* L., *Festuca* L., *Hainardia* Greuter, *Lamarckia* Moench, *Lolium* L., *Parapholis* C.E.Hubb., *Poa* L., *Puccinellia* Parl., *Sphenopus* Trin. and *Vulpia* C.C.Gmel. (Gibbs Russell *et al.* 1990).

The aim of this study is to determine the chromosome numbers, polyploid levels and meiotic chromosome behaviour of the South African representatives of the tribe Poeae. These results will, eventually, be compared with the results obtained from indigenous and endemic taxa to compare the frequency of polyploidy between indigenous and introduced grasses.

MATERIALS AND METHODS

For the purpose of this study, cytogenetic material was collected in two different ways. The material was either collected and fixed in the field, or living material was collected in the field and transplanted in the nurseries of either the Department of Botany and Genetics, University of the Orange Free State (Bloemfontein) or the National Botanical Institute (Pretoria), where the cytogenetic material was collected and fixed. The specimens used and their localities are listed in Table 1. Voucher specimens are housed either in the Geo Potts Herbarium, Department of Botany and Genetics, University of the Orange Free State, Bloemfontein (BLFU) or in the National Herbarium, Pretoria (PRE).

Anthers were squashed in aceto-carmine and meiotically analysed (Spies *et al.* 1996a). Chromosome numbers are presented as haploid chromosome numbers to conform to previous papers on chromosome numbers in this journal (Spies & Du Plessis 1986a). Genome homology in some tetraploid specimens was determined according to the models described by Kimber & Alonso (1981).

RESULTS AND DISCUSSION

Briza consists of 16 species, with three (*B. maxima* L., *B. minor* L. and *B. subaristatum* Lam.) being naturalized in South Africa. Two of these species were studied. Both were diploid with *B. maxima* having the haploid chromosome number seven (n = x = 7) and *B. minor* five (n = x = 5) (Table 1). These findings confirm previous reports on chromosome numbers for these species by Fedorov 1969; Ornduff 1967–1969; Moore 1970, 1971, 1972, 1974, 1977; Goldblatt 1981, 1983, 1985, 1988; Goldblatt & Johnson 1990, 1991, 1994, who observed tetraploid *Briza* specimens in several species. However, polyploidy seems to be absent in both *B. maxima* and *B. minor* specimens studied here and abroad. Meiosis was regular in both species, and bivalents were formed (Figure 1A & B). These results, in combination with the available chromosome numbers given in the literature consulted, indicate that *Briza* has two basic chromosome numbers, namely five and seven.

Catapodium consists of two species, one of which is naturalized in South Africa [*C. rigidum* (L.) C.E.Hubb.]. Three of the studied specimens were diploid (n = x = 7), whereas the other specimen was tetraploid (n = 2x = 14) (Table 1). The diploid chromosome number observed sup-

* Department of Botany and Genetics, University of the Orange Free State, P.O. Box 339, Bloemfontein 9300.
** National Botanical Institute, Private Bag X101, Pretoria 0001.
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TABLE 1.—Haploid chromosome numbers of representatives of the tribe Poeae (Poaceae, Pooideae) in southern Africa with their voucher specimen numbers and specific localities. Species are listed alphabetically, voucher numbers within a species numerically and the locality is presented according to the system described by Edwards & Leistner (1971)

Taxon	Voucher No.	n	Locality
Briza maxima	*Spies 3159*	7	WESTERN CAPE.—3218 (Clanwilliam): Versveld Pass, (–DC)
	Spies 3548	7	WESTERN CAPE.—3421 (Riversdale): 4 km from Kweekkraal to Droërivier, (–AA)
	Spies 4420	7	WESTERN CAPE.—3318 (Cape Town): 19 km from Darling to Malmesbury, (–AD)
B. minor	*Spies 3239a*	5	NORTHERN CAPE.—3229 (Sutherland): 10 km from Sutherland to Matjiesfontein, (–BC)
	Spies 3903	5	WESTERN CAPE.—3418 (Simonstown): Redhill, (–AB)
	Spies 4425	5	WESTERN CAPE.—3318 (Cape Town): Bothmaskloof, (–BC)
	Spies 4641	5	WESTERN CAPE.—3420 (Bredasdorp): 4 km N of De Hoop Nature Reserve, (–AD)
Catapodium rigidum	*Davidse 33794*	7	WESTERN CAPE.—3420 (Bredasdorp): 20 km from Bredasdorp to Spitskop, (–CA)
	Spies 3451	14	WESTERN CAPE.—3420 (Bredasdorp): 6 km from Ouplaas to De Hoop Nature Reserve, (–AD)
	Spies 3854	7	WESTERN CAPE.—3319 (Worcester): 1 km south of old toll house in Mitchell's Pass, (–AD)
	Spies 3906	7	WESTERN CAPE.—3418 (Simonstown): Redhill, (–AB)
Dactylis glomerata	*Spies 4849*	7	EASTERN CAPE.—3228 (Butterworth): on beach at Bonza Bay, (–CC)
Festuca caprina	*Du Plessis 14*	14	MPUMALANGA.—2530 (Lydenburg): 18 km from Lydenburg to Weltevreden, (–AB)
	Saayman 116	14	MPUMALANGA.—2530 (Lydenburg): 6 km from Dullstroom to Goede Hoop, (–AC)
F. costata	*Spies 4692*	14	EASTERN CAPE.—3028 (Matatiele): 47 km from Rhodes in Naude's Neck, (–CC)
F. elatior	*Spies 2497*	14	EASTERN CAPE.—3027 (Barkly East): Beestekraal se loop, (–DC)
F. scabra	*Saayman 51*	14	MPUMALANGA.—2530 (Lydenburg): 16 km from Lydenburg to Sabie, (–BA)
	Saayman 99	14	MPUMALANGA.—2530 (Lydenburg): 17 km from Lydenburg to Roossenekal, (–AB)
	Davidse 33628, 34090	14	EASTERN CAPE.—3424 (Humansdorp): 10 km from Humansdorp to Cape St Francis, (–BB)
	Spies 3557	7	WESTERN CAPE.—3421 (Riversdale): 25 km from Droërivier to Vermaaklikheid via Oudemuragie, (–AC)
	Spies 3627	14	WESTERN CAPE.—3319 (Worcester): 7 km from Villiersdorp to Franschhoek, (–CC)
	Spies 3962	14	EASTERN CAPE.—3127 (Lady Frere): 9 km from Dordrecht to Barkly East, (–AC)
	Spies 4452	14	WESTERN CAPE.—3319 (Worcester): 6 km from Franschhoek to Villiersdorp, (–CC)
Hainardia cylindrica	*Spies 3192*	7	WESTERN CAPE.—3318 (Cape Town): 1 km east of Mamre Road, (–BC)
Lolium multiflorum	*Spies 1986*	7	MPUMALANGA.—2530 (Lydenburg): 14 km from Dullstroom to Lydenburg, (–AC)
	Spies 2506	7	EASTERN CAPE.—3027 (Lady Grey): near Barkly East, (–DC)
	Spies 2663	7	FREE STATE.—2826 (Brandfort): Glen, (–CD)
	Spies 3191	7	WESTERN CAPE.—3318 (Cape Town): 1 km east of Mamre Road, (–BC)
	Spies 4428	7	WESTERN CAPE.—3319 (Worcester): 8 km from Wellington to Worcester in Bainskloof, (–CA)
L. perenne × *L. multiflorum*	*Davidse 33572*	7	EASTERN CAPE.—3325 (Port Elizabeth): King Neptune Beach, (–DC)
	Spies 3155	7	WESTERN CAPE.—3319 (Worcester): Katbakkies turn-off on road between Ceres and Citrusdal, (–AB)
L. rigidum	*Spies 3183*	7	WESTERN CAPE.—3217 (Vredenburg): on beach outside Cape Columbine Nature Reserve, (–DD)
	Spies 3190	7	WESTERN CAPE.—3318 (Cape Town): 1 km east of Mamre Road, (–BC)
L. temulentum	*Spies 3386*	7	WESTERN CAPE.—3017 (Hondeklipbaai): dunes at Groenrivier Mouth, (–DC)
	Spies 4569	7	WESTERN CAPE.—3318 (Cape Town): 7 km from Yzerfontein to Darling, (–AC)
	Spies 4576	7+1B	WESTERN CAPE.—3318 (Cape Town): 5 km from Langebaan to Langebaanweg, (–DC)
	Spies 4595	7+0–2B	WESTERN CAPE.—3320 (Montagu): 22 km from Villiersdorp to Worcester via Koppies, (–AD)
	Spies 4637	7	WESTERN CAPE.—3420 (Bredasdorp): De Hoop Nature Reserve, (–AD)
	Spies 4722	7	EASTERN CAPE.—3027 (Lady Grey): 34 km from Rhodes to Lundean's Neck, (–DD)
Lolium sp.	*Spies 5062*	7	FREE STATE.—2729 (Volksrust): Verkykerskop, (–CC)
Parapholis incurva	*Spies 3422*	7	WESTERN CAPE.—3218 (Clanwilliam): 5 km south of Elandsbaai, (–AB)
	Spies 3429	7	WESTERN CAPE.—3318 (Cape Town): 1 km north of Uilekraal on road between Hopefield and Darling, (–AB)
	Spies 3500	19	EASTERN CAPE.—3424 (Humansdorp): 10 km from Humansdorp to Cape St Francis, (–BB)
	Spies 4596	19	WESTERN CAPE.—3320 (Montagu): 22 km from Villiersdorp to Worcester via Koppies, (–AD)
	Spies 5349	21	WESTERN CAPE.—3118 (Vanrhynsdorp): 2 km from Doornbaai to Donkinbaai, (–CB)
Poa annua	*Saayman 103 & 110*	14	MPUMALANGA.—2530 (Lydenburg): 39 km from Lydenburg to Roossenekal, (–AA)
	Spies 3193	14	WESTERN CAPE.—3318 (Cape Town): 1 km east of Mamre Road, (–BC)
P. binata	*Saayman 117*	21	MPUMALANGA.—2530 (Lydenburg): 6 km from Goede Hoop to Dullstroom, (–AC)
	Spies 4680	28	EASTERN CAPE.—3028 (Matatiele): 12 km from Rhodes in Naudesnek, (–CC)
P. bulbosa	*Spies 3052*	21	NORTHERN CAPE.—3017 (Hondeklipbaai): 6 km from Kamieskroon in Kamiesberg Pass, (–BB)
P. pratensis	*Spies 3196*	21	WESTERN CAPE.—3318 (Cape Town): Afrikaanse taal memorial, (–DD)
Puccinellia acroxantha	*Spies 3126*	21	NORTHERN CAPE.—3119 (Calvinia): 20 km from Calvinia to Loeriesfontein, (–AB)
	Spies 3134	21	NORTHERN CAPE.—3220 (Sutherland): 2 km from Sutherland to Calvinia, (–BC)
P. angusta	*Spies 3187*	7	WESTERN CAPE.—3318 (Cape Town): Tinie Versveld Nature Reserve, (–AD)
Puccinellia sp.	*Davidse 33447*	7	WESTERN CAPE.—3218 (Clanwilliam): 5 km south of Bobbejaanberg Point, Elandsbaai, (–AD)
	Davidse 33910	7	WESTERN CAPE.—3318 (Cape Town): 10 km from Wellington to Porterville, (–DB)
	Spies 3154	7	WESTERN CAPE.—3319 (Worcester): Katbakkies turn-off on road between Ceres and Citrusdal, (–AB)
Sphenopus divaricatus	*Spies 3426, 3427*	7	WESTERN CAPE.—3218 (Clanwilliam): 5 km south of Eland's Bay, (–AB)
Vulpia bromoides	*Spies 3061*	21	NORTHERN CAPE.—3018 (Kamiesberg): 16 km east of Kamieskroon, (–AC)
	Spies 3632	7	WESTERN CAPE.—3319 (Worcester): 4 km to Franschhoek from turn-off on Villiersdorp-Grabouw road, (–CC)
V. fasciculata	*Spies 3900*	14	WESTERN CAPE.—3418 (Simonstown): Silvermine Nature Reserve, (–AB)
V. muralis	*Spies 3987*	21	EASTERN CAPE.—3027 (Lady Grey): 45 km from Barkly East to Rhodes, (–DD)
V. myuros	*Spies 3153*	21	WESTERN CAPE.—3319 (Worcester): Katbakkies turn-off on road between Ceres and Citrusdal, (–AB)
	Spies 4936	21	NORTHERN CAPE.—3018 (Kamiesberg): 21 km from Kamieskroon to Gamoep, (–AC)

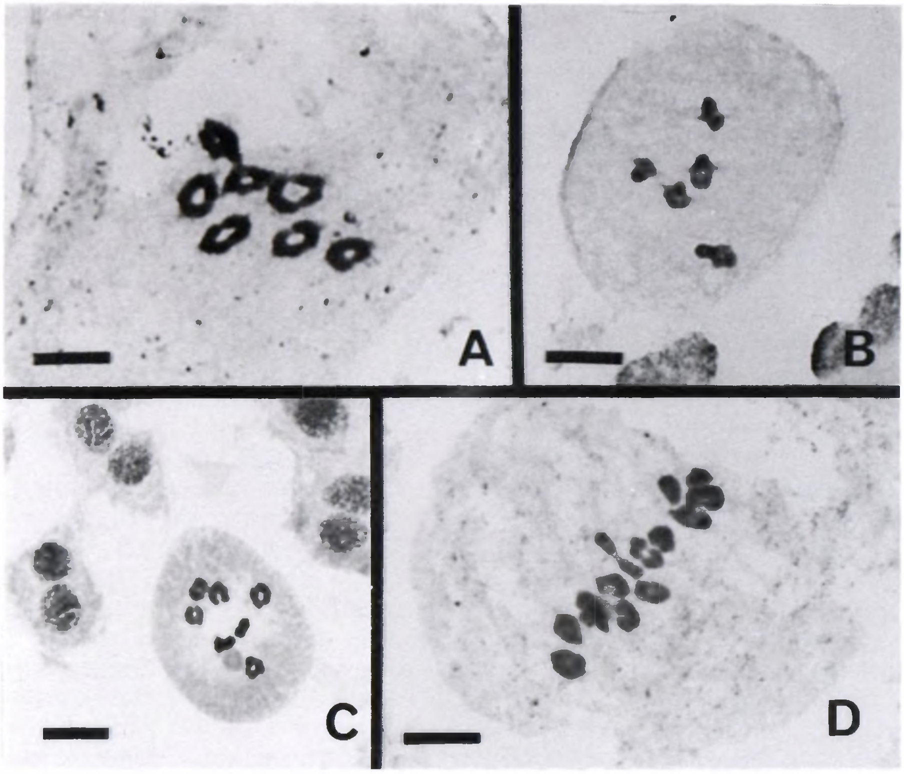

FIGURE 1.—Photomicrographs of meiotic chromosomes in the genera *Briza* and *Catapodium*. A, *B. maxima*, *Spies 4420*, diakinesis with 7_{II}; B, *B. minor*, *Spies 4425*, diakinesis with 5_{II}; C, *C. rigidum*, *Spies 3854*, diakinesis with 7_{II}; D, *C. rigidum*, *Spies 3451*, metaphase I with 14_{II}. Scale bars: 10 µm.

ports the previous numbers recorded by various authors (Fedorov 1969; Ornduff 1967–1969; Moore 1970, 1971, 1972, 1974, 1977; Goldblatt 1981, 1983, 1985, 1988; Goldblatt & Johnson 1990, 1991, 1994). To the best of our knowledge, the tetraploid number observed is a new ploidy level for *C. rigidum*. Tetraploid specimens have, however, been observed in the other *Catapodium* species. Both ploidy levels studied, formed bivalents only (Figure 1C & D) and meiosis was normal. This indicates that the tetraploid specimen may be of alloploid origin.

In this study the alloploid origin of the tetraploid *C. rigidum* specimen is supported by its genome constitution analysis, in which the observed chromosome associations concurred best with the associations expected for the 2:2 model of Kimber & Alonso (1981) (Table 2). This model indicates that two sets of genomes are present (two genomes per set) and the relative similarity between the genomes within a set is 0.5. The relative similarity between sets of genomes is expressed by an x-value that may vary between 0.5 (differences between sets are simi-

TABLE 2.—Genomic relationships in some tetraploid representatives of the tribe Poeae (Poaceae, Pooideae) in southern Africa according to the models of Kimber & Alonso (1981). The number in square brackets indicates the relative affinity of the different genomes

Species	Voucher#	4:0	3:1	2:2	2:1:1
Catapodium rigidum	*Spies 3451*	9.57	9.94 [0.5055]	2.17 [0.9995]	6.83 [0.9555]
Festuca caprina	*Du Plessis 14*	7.97	9.65 [0.9185]	0.93 [1]	3.45 [0.956]
	Saayman 116	8.69	9.87 [0.956]	0.85 [0.95]	2.65 [0.971]
F. costata	*Spies 4692*	10.56	14.35 [0.9915]	3.14 [1]	8.65 [0.9903]
F. elatior	*Spies 2497*	9.09	9.97 [1]	0.3 [1]	1.47 [0.9815]
F. scabra	*Davidse 34090*	14.33	14.48 [0.9805]	0.02 [1]	0.14 [0.95]
	Saayman 51	11.11	11.43 [0.971]	6.25 [1]	0.29 [1]
	Saayman 99	9.84	10.32 [0.926]	0.14 [1]	0.77 [0.9915]
	Spies 3627	8.92	9.79 [0.955]	0.38 [1]	1.79 [0.9805]
	Spies 3962	9.9	13.32 [1]	2.5 [1]	7.4 [0.926]
	Spies 4452	9.67	12.9 [1]	2.27 [1]	7.14 [0.955]

lar to the differences within a set, therefore the genomes may be presented in the form of AAAA) and 1 (sets differing greatly, therefore the genomes may be presented as AABB). The x-value for the tetraploid *C. rigidum* specimen is almost 1 (Table 2) and, therefore, very little to no homology exists between the two chromosome sets (genomes may be presented by AAA'A', where A differs greatly from A').

Colpodium contains three species, with *C. hedbergii* (Melderis) Tzvelev being indigenous to this country. This species was not included in this study. However, chromosome numbers of 2n = 4, 8, 14 and 28 have been reported for the genus *Colpodium* (Ornduff 1967–1969; Moore 1970, 1971, 1972, 1974, 1977; Goldblatt 1981, 1983, 1985, 1988; Goldblatt & Johnson 1990, 1991, 1994), and 2n = 8 for *C. hedbergii* (Hedberg & Hedberg 1977). Further studies are necessary to determine the basic chromosome number of this genus and also to determine the phylogenetic development of chromosome numbers.

Cynosurus has eight species worldwide, with *C. coloratus* Lehm. ex Nees being a very rare indigenous species and *C. echinatus* L. a naturalized species. Neither of these species was included in this study. Chromosome number reports indicate that all species studied are diploid and *C. echinatus* was included in some of those studies (Ornduff 1967–1969; Moore 1970, 1971, 1972, 1974, 1977; Goldblatt 1981, 1983, 1985, 1988; Goldblatt & Johnson 1990, 1991, 1994).

Dactylis is represented in South Africa by one naturalized species (*D. glomerata* L.). The specimen of *D. glomerata* studied, was diploid (Table 1). This finding supports the various chromosome number reports of 2n = 14 or 28 for *D. glomerata*, as well as for the genus *Dactylis* in general (Fedorov 1969; Ornduff 1967–1969; Moore 1970, 1971, 1972, 1974, 1977; Goldblatt 1981, 1983, 1985, 1988; Goldblatt & Johnson 1990, 1991, 1994).

Festuca has approximately 360 species worldwide and is represented by eight indigenous species: *F. africana* (Hack.) Clayton, *F. caprina* Nees, *F. costata* Nees, *F. dracomontana* H.P.Linder, *F. killickii* Kenn.-O'Byrne, *F. longipes* Stapf, *F. scabra* Vahl and *F. vulpioides* Steud., and one naturalized species: *F. elatior* L. (= *F. arundinacea).* Four *Festuca* species were included in this study. They were all found to be tetraploid except for one of the seven specimens of *F. scabra,* which was diploid (Table 1). In this study the tetraploid chromosome numbers (n = 2x = 14) were observed for *F. caprina*; this represents a new ploidy level for this species. Previous reports gave an octoploid number (n = 4x = 28) for this species (Spies & Du Plessis 1986a, b). This study confirms a tetraploid chromosome number (n = 2x = 14) for *F. costata* (De Wet 1958). The tetraploid number (n = 2x = 14) for *F. elatior* is in support of one of the ploidy levels previously described for this species, namely 2n = 14, 28, 42, 56 and 70 (Fedorov 1969; Ornduff 1967–1969; Moore 1970, 1971, 1972, 1974, 1977; Goldblatt 1981, 1983, 1985, 1988; Goldblatt & Johnson 1990, 1991, 1994). *Festuca longipes* was not included in this study but Hill (1965) reported a hexaploid number for this species. This is the first study to report a diploid chromosome number for *F. scabra.* The tetraploid number observed confirms the level previously reported with nonaploid and decaploid numbers (De Wet & Anderson 1956; De Wet 1958; Spies & Du Plessis 1986a, b). The chromosome numbers of four South African species of *Festuca* are still unknown, i.e. *F. africana*, *F. dracomontana*, *F. killickii* and *F. vulpioides*.

Meiosis was normal in most specimens, with only bivalents being formed (Figure 2), excepting a telophase I cell with four micronuclei in *F. costata* (Figure 2C) and a telophase II cell in one *F. scabra* specimen, *Spies 3962*, with a micronucleus and the possible remnants of an anaphase II bridge (Figure 2E). This low frequency of abnormalities (less than one cell in the forty cells studied per specimen), may be attributed to accidental misdivisions. The presence of only bivalents found in the tetraploid specimens of *F. caprina* (Figure 2A), *F. costata* (Figure 2B), *F. elatior* and *F. scabra* (Figure 2D), suggests that these species have alloploid origins.

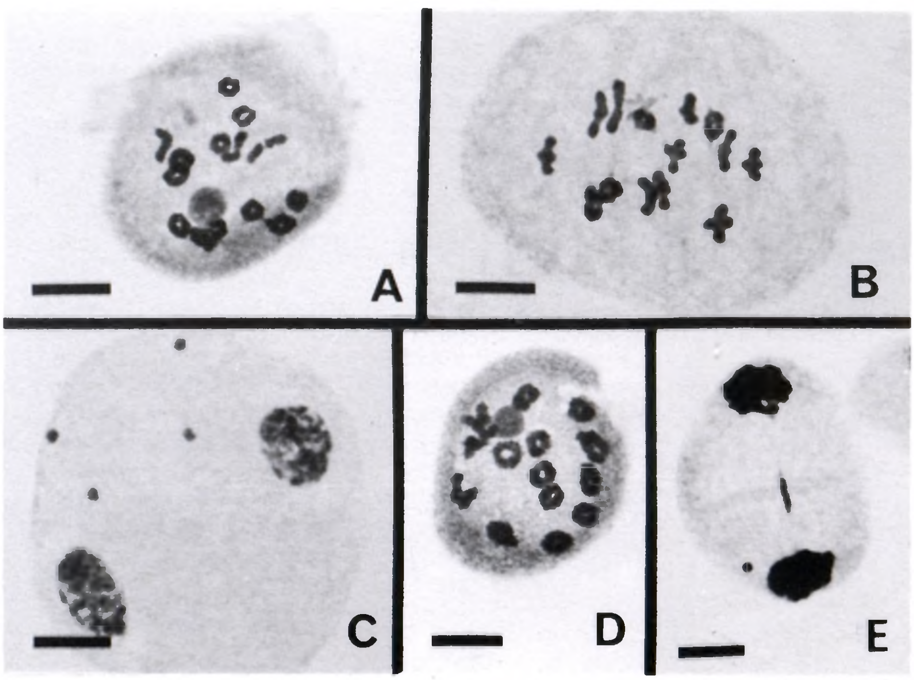

FIGURE 2.—Photomicrographs of meiotic chromosomes in the genus *Festuca*. A, *F. caprina*, *Saayman 116*, diakinesis with 14_{II}. B, C, *F. costata*, *Spies 4692*: B, metaphase I with 14_{II}; C, telophase I with four micronuclei. D, E, *F. scabra*: D, *Saayman 99*, diakinesis with 14_{II}; E, *Spies 3962*, telophase II with micronucleus and possible remnant of anaphase II bridge. Scale bars: 10 µm.

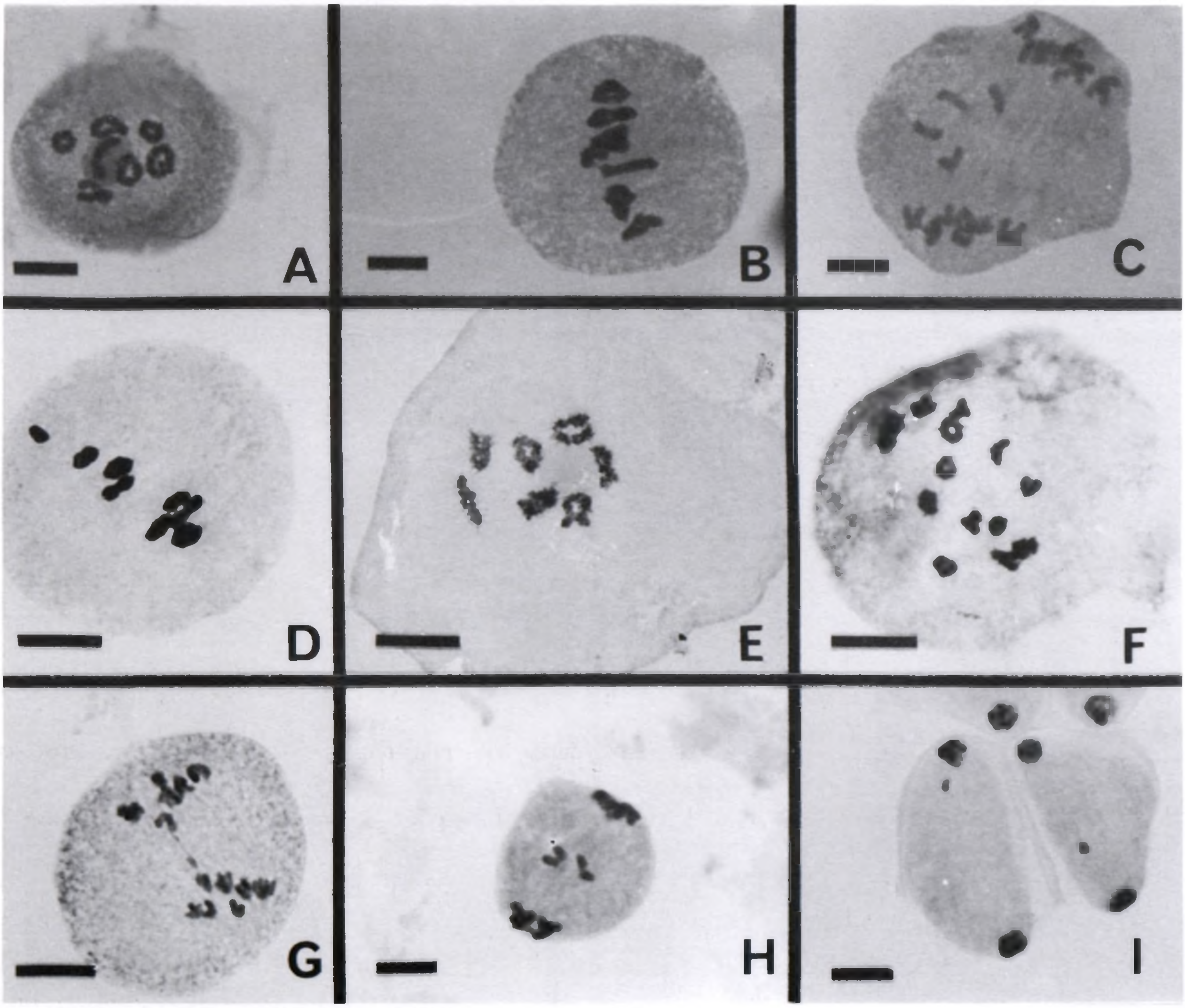

FIGURE 3.—Photomicrographs of meiotic chromosomes in the genus *Lolium*. A, *L. rigidum*, *Spies 3190*, diakinesis with 7_{II}; B, *L. perenne* × *L. multiflorum*, *Spies 2463*, metaphase I with 7_{II}; C, *L. multiflorum*, *Spies 4428*, anaphase I with 4 laggards. D–G, *L. temulentum*: D, *Spies 4567*, metaphase I with 7_{II} + 1B; E, *Spies 4637*, diplotene with 7_{II}; F, *Spies 4637*, diakinesis with 14_{II}; G, *Spies 4569*, anaphase I with chromatin strand connecting two segregating chromosomes. H, I, *Lolium* sp., *Spies 5062*: H, anaphase II with four laggards; I, telophase II with two micronuclei. Scale bars: 10 μm.

Genome analyses of all tetraploid *Festuca* specimens indicated that, in each case, the observed chromosome associations concurred best with the expected associations for the 2:2 model (Table 2). The x-values varied from 0.95 to 1 and the analysed specimens of all four species suggest an alloploid origin (Table 2).

Hainardia is a monotypic genus, and *H. cylindrica* (Willd.) Greuter is naturalized in this country. We observed a diploid chromosome number of n = x = 7 in this species (Table 1). This number deviates from the 2n = 26 given in the literature (Scrugli & Bocchieri 1977, mentioned in Goldblatt 1981). Further studies of this extremely rare species are necessary to determine its basic chromosome number and the possible evolutionary change from x = 7 to x = 13.

Lamarckia aurea (L.) Moench represents another monotypic naturalized genus in South Africa. No suitable material of this species could be obtained for this study. All the published chromosome numbers given agree that the species is diploid (2n = 2x = 14) (Fedorov 1969; Moore 1970, 1971, 1972, 1974, 1977; Goldblatt 1988; Goldblatt & Johnson 1994).

Four species of the genus *Lolium* are naturalized in South Africa, i.e. *L. multiflorum* Lam., *L. perenne* L., *L. rigidum* Gaudin and *L. temulentum* L. All four species were studied and were all diploid (Figure 3A, B, D & E), thus confirming previous chromosome number reports (Fedorov 1969; Ornduff 1967–1969; Moore 1970, 1971, 1972, 1974, 1977; Goldblatt 1981, 1983, 1985, 1988; Goldblatt & Johnson 1990, 1991, 1994). A single tetraploid cell was observed in a *L. temulentum* specimen (Figure 3F). This tetraploid cell may be attributed to cell fusion (Spies & Van Wyk 1995). A few meiotic abnormalities were observed. They include anaphase I laggards (Figure 3C), the presence of B-chromosomes (Figure 3D), an anaphase I bridge (Figure 3G), anaphase II laggards (Figure 3H) and telophase II micronuclei (Figure 3I).

The genus *Parapholis* comprises six species, but only *P. incurva* (L.) C.E.Hubb. is locally naturalized. Five specimens were included in this study (Table 1). With a

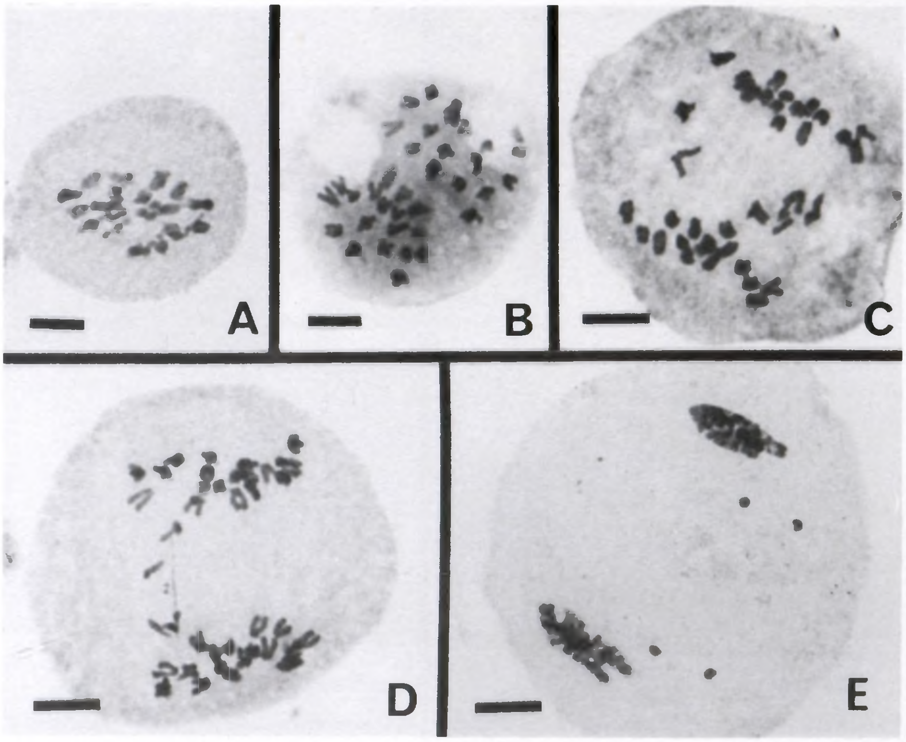

FIGURE 4.—Photomicrographs of meiotic chromosomes in *Parapholis incurva*. A, *Spies 5349*, metaphase I with 19II. B–E, *Spies 4596*: B, anaphase I with 18-18 segregation of chromosomes; C, anaphase I with chromosome laggards; D, anaphase I with chromatid bridge; E, telophase I with four micronuclei. Scale bars: 10 µm.

basic chromosome number of 7, two specimens were diploid (n = x = 7), two aneuploid (n = 18 and n = 19) (Figure 4A & B), and one hexaploid (n = 3x = 21). These conflicting chromosome numbers are accentuated by the literature consulted, where 2n = 24 (Goldblatt & Johnson 1994), 28 (Moore 1977), 36 (Fedorov 1969; Moore 1972; Goldblatt 1981), 38 (Fedorov 1969; Moore 1972; Goldblatt 1981) and 42 (Fedorov 1969) are found for *P. incurva*. Other *Parapholis* species are either diploid (2n = 14) (Fedorov 1969) or tetraploid (2n = 28) (Moore 1972). Further studies in *P. incurva* are needed to determine the evolution of chromosome numbers.

Meiosis was relatively normal and abnormalities were only observed in the aneuploid specimens (Figure 4). These abnormalities include chromosome laggards during anaphase I (Figure 4C), a chromatid bridge during anaphase I (Figure 4D) and micronuclei during telophase I (Figure 4E).

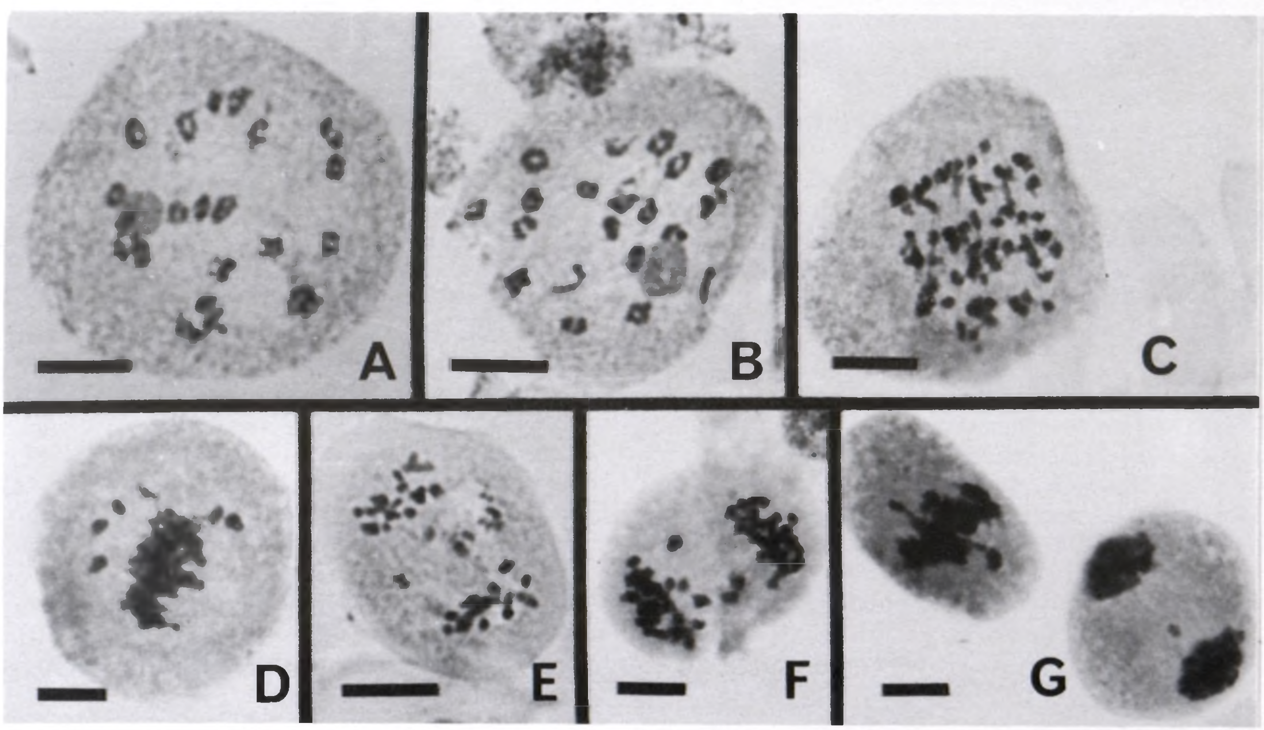

FIGURE 5.—Photomicrographs of meiotic chromosomes in the genus *Poa*. A, B, *P. binata*, *Saayman 117*, diakinesis with 21II. C–G, *P. pratensis*: C, *Spies 4670*, diakinesis; D, *Spies 4670*, metaphase I with several univalents; E, *Spies 3196*, anaphase I with laggards; F, *Spies 4720*, anaphase I with laggards; G, *Spies 4720*, telophase I with micronucleus. Scale bars: 10 µm.

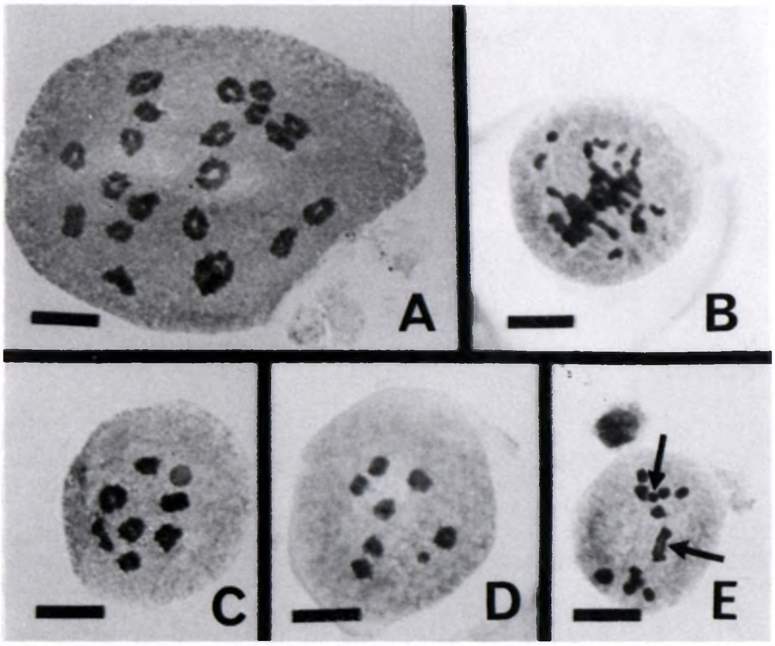

FIGURE 6.—Photomicrographs of meiotic chromosomes in the genus *Puccinellia*. A, B, *P. acroxantha*: A, *Spies 3126*, diakinesis with 21_{II}; B, *Spies 3134*, metaphase I with various univalents. C, *P. angusta*, *Spies 3157a*, diakinesis with 7_{II}; D, *Puccinnellia* sp., *Spies 3154*, diakinesis with 7_{II} + 1B; E, *P. angusta*, *Spies 3157a*, anaphase I with a chromosome bridge and either a B-chromosome or fragment in upper pole (see arrows). Scale bars: 10 µm.

The largest genus in the Poeae, *Poa*, consists of approximately 500 species, with three indigenous species (*P. binata* Nees, *P. bulbosa* L. and *P. leptoclada* A.Rich.) and three naturalized species (*P. annua* L., *P. pratensis* L. and *P. trivalvis* L.). Four of these species were studied. The *P. annua* specimens were tetraploid, *P. binata* had one hexaploid (Figure 5A & B) and one octoploid specimen, whereas all the *P. bulbosa* and *P. pratensis* specimens were hexaploid (Figure 5C). To the best of our knowledge, this is the first report on chromosome numbers for *P. binata*. The rest of our chromosome number reports support the previous counts made for *P. annua*, *P. bulbosa*, *P. pratensis* and *P. trivalvis*.

Meiosis was abnormal in the *P. pratensis* specimen (n = 21). These abnormalities included numerous univalents during metaphase I (Figure 5D), chromosome laggards during anaphase I (Figure 5E & F) and micronuclei during telophase I (Figure 5G).

There are ± 80 species in the genus *Puccinellia*, with three indigenous species, *P. acroxantha* C.A.Sm. & C.E.Hubb., *P. angusta* (Nees) C.A.Sm. & C.E.Hubb. and *P. fasciculata* (Torr.) C.Bicknell; and a naturalized species *P. distans* (L.) Parl. The *Puccinellia acroxantha* specimens were hexaploid (Figure 6A) and the *P. angusta* specimen was diploid (Figure 6C & D). These are thought to be the first reports on chromosome numbers for both species. A metaphase I cell with many univalents was observed (Figure 6B) in one *P. acroxantha* specimen. One B-chromosome was present in some cells of *P. angusta* (Figure 6D) and a chromosome bridge was observed in one cell of this species (Figure 6E).

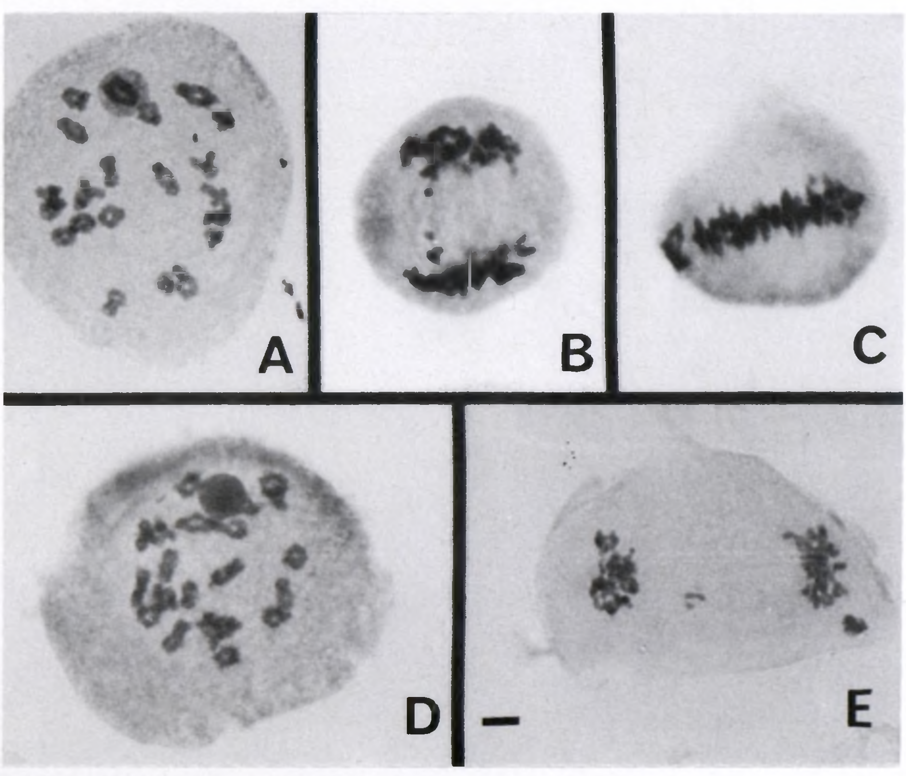

FIGURE 7.—Photomicrographs of meiotic chromosomes in the genus *Vulpia*. A, B, *V. bromoides*, *Spies 3061*: A, diakinesis with 21_{II}; B, anaphase I with chromosome laggards. C, *V. muralis*, *Spies 3987*, metaphase I. D, E, *V. myuros*, *Spies 4936*: D, diakinesis with 21_{II}; E, anaphase I with chromosome laggard. Scale bar: 10 µm.

The genus *Sphenopus* contains two species, with only *S. divaricatus* being naturalized in South Africa. Both *S. divaricatus* specimens were diploid with n = x = 7. This finding contradicts the previous numbers based on six as listed in Moore 1972 & 1974 and Goldblatt 1981, and supports the 2n = 28 listed in Moore 1972 & 1974.

Four of the 23 species of the genus *Vulpia* are naturalized in South Africa, i.e. *V. bromoides* (L.) Gray, *V. fasciculata* (Forssk.) Samp., *V. muralis* (Kunth) Nees and *V. myuros* (L.) C.C.Gmel. One *Vulpia bromoides* specimen was diploid, the other was hexaploid (Figure 7A), *V. fasciculata* was tetraploid and *V. muralis* (Figure 7C) and *V. myuros* (Figure 7D) were hexaploid. These numbers confirm the previous reported findings (Fedorov 1969; Ornduff 1967–1969; Moore 1970, 1971, 1972, 1974, 1977; Goldblatt 1981, 1983, 1985, 1988; Goldblatt & Johnson 1990, 1991, 1994). Meiosis was normal in most cells with occasional chromosome laggards during anaphase I (Figure 7B & E).

This study confirms a basic chromosome number of seven for the tribe Poeae. Further studies are, however, necessary to determine the origin of the other basic chromosome numbers present in the tribe. In this regard *Briza* (x = 5 & 7), *Colpodium* (x = 7 and an aneuploid reduction series exists, or x = 2), *Hainardia* (x = 7 or 13), *Parapholis* (x = 7, 18 or 19) and *Sphenopus* (x = 6 or 7) should receive special attention.

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