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Cytogenetical Studies of Himalayan Aceraceae, Hippocastanaceae, Sapindaceae and Staphyleaceae

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(Received May 1971)

Introduction

The forests in the Himalayas vary a great deal in composition. The conifers are of relatively little importance in contrast to the vast representation of hardwood species. Amongst 180 recognised commercial timbers of this region, less than a dozen are softwoods. For any rational programme of the tree improvement on cytogenetical lines, it is pertinent to have prior information on their chromosome number, meiotic behaviour, morphological and cytological variability, if any, geographical or ecological races and flowering and fruiting season. Almost complete lack of such data on species under review promoted the present studies.

Materials and Methods

Material for meiotic studies was collected from wild sources, excepting a few exotics, in the Himalayas. Flower buds were fixed in CARNOY's fluid. Squashing of anthers was accomplished in 1% aceto-carmine. Slides were made permanent in Euparal. Figures are at a uniform magnification of X 1360. Voucher specimens have been deposited in the Herbarium, Panjab University, Department of Botany, Chandigarh-14 (India). The genera and species under each family are arranged in the succeeding pages after HOOKER (1872), but those of forestry importance are dealt with first. Numerical strength of the genera and families is adopted from WILLIS (1966).

Results

The chromosome counts of 30 species belonging to 10 genera and 4 families are given in Table 1. Of these, 21 species, a variety and 4 genera are cytologically worked out for the first time. The course of meiosis has been observed to be normal in all taxa. Detailed observations have been given only for a few species of morphological or cytological interest.

ACERACEAE:

The family is comprised of 3 genera primarily of the North temperate hemisphere. *Acer* with 200 species is the largest genus. The maples are famous for their handsome foliage. A. saccharum of North America is tapped for sugar. Several species produce timber. GAMBLE (1902) states, "structure of all Maples, Indian included, is very uniform and most of the Indian species possess the handsome silver grain characteristic of Maple wood in general". The genus is not well appreciated in India because of its distribution in the localities of difficult approach in the temperate Himalayas. Fifteen species, besides some exotics inhabit the Himalayas. Of these, A. thomsoni, A. campbellii, A. osmastoni, A. niveum, A. hookeri, A. pectinatum, A. *sikkimense*, A. papilio and A. stachyphyllum are restricted to E. Himalayas, A. caesium is confined to W. Himalayas and A. oblongum, A. pictum, A. *villosum,* A. caudatum and A. laevigatum are met both in the E. and W. Himalayas. Five species A. oblongum, A. caesium, A. thomsoni, A. *campbellii* and A. pictum yield timber of commercial value.

A. campbellii is the commonest maple of the Eastern Himalayas, often making Oak-Laurel-Maple association. It has a wide altitudinal range from 1800–3600 m. Tall deciduous tree, 20–40 m. in height and 2–5 m. in girth with a clear straight bole upto 12 m. high.

The species is known for its heterophyllous nature. BANERJI (1958) segregated the species into two varieties, campbellii and serratifolia, the former with serrulate margin, glabrous nerves and dense inflorescence and the latter showing serrate margin, pubescent nerves and elongate inflorescence. The present field observations in the Darjeeling hills revealed the occurrence of an intermediate type with smaller and less serrated leaves than var. serratifolia (Fig. A). It has been observed that the plants possessing 5–7 lobed deeply cut leaves with serrate margin occupy distribution range of 2100—2600 m., intermediate ones with 5 lobed serrulate and dark green leaves occur between 2400—2800 m., while those having 7 lobed conspicously serrate leaves are met with above 2600 m. ascending upto timber line where they become stunted.

At M-I, 13 bivalents are seen (Fig. 4). The taxa corresponding to varieties campbellii and serratifolia show 90% well filled and stainable pollen. The populations with inter-

Table 1. — Summary of cytological observations, along with specific locality, flowering and fruiting season and previous reports. "E" donates Eastern Himalayas and "W" Western Himalayas. For flowering and fruiting, numbers 1—12 represent months January to December.

Name	Locality, with altitude in meters	Flowering and fruiting season	Chromosome number	Fig. No.	Previous reports
ACERACEAE					
Acer oblongum WALL.	Darjeeling, Rimbak, 2000, E Nainital, 1950, W	2—3; 8—2	n = 13	1	
A. caesium WALL.	Nainital, 1950, W	3—4; 10—11	n = 13	2	
A. thomsoni MIQ.	Darjeeling, Ging, 1800, E	9—10; 10—4	n = 13	3	
A. campbellii HOOK. f. & T.	Darjeeling, Jalapahar, 2300, E Sukhiapokhri, 2500, E Tonglu, 3000, E	3—4; 8—9	n = 13	4	
A. pictum THUNB.	Nainital, Lariakanta, 2400, W	3—4; 9—10	n = 13	5	2n = 26: TAKIZAWA, 1952.
A. osmastoni GAMBLE.	Darjeeling, Birch hill, 2300, E.	2—3; 5—9	n = 13	6	
A. villosum WALL.	Darjeeling, Rimbak, 2000, E	10—11; 11—2	n = 13		
	Nainital, 1950, W	3—4	n = 13 + 0—2B's	7	
A. niveum BL.	Upper Assam, Jaypore, 300, E	2—3; 6—10	n = 13	8	
A. caudatum WALL.	Nainital, Pangot, 1800, W	3—4; 11—3	n = 13	9	
A. hookeri MIQ.	Darjeeling, Senchal, 2500, E	3—4; 8—9	n = 13	10	
A. pectinatum WALL.	Darjeeling, Tonglu, 3000, E	4—5; 9—10	n = 13	11	
A. laevigatum WALL.	Darjeeling, 2200, E Nainital, 1950, W	3—4; 5—10	n = 13	12	
A. sikkimense MIQ.	Darjeeling, Birch hill, 2300, E	4—5; 6—8	n = 13	13	
A. papilio KING.	Darjeeling, Sandakhphu, 3500, E	9—10; 12—6	n = 13	14	
A. stachyphyllum HIERN.	Sikkim, Gangtok, 2300, E	4—5; 11—12	n = 13	15	
A. japonicum THUNB.	Darjeeling, 2200, E (Cultivated)	2—3; 4—6	n = 13	16	2n = 26: TAKIZAWA, 1952.
A. palmatum THUNB.	Nainital, 1950, W (Cultivated)	2—3; 4—6	n = 13		2n = 26: TAKIZAWA, 1952.
A. palmatum var. *versicolor* SCHWER.	Darjeeling, 2200, E (Cultivated)	2—4; 5—7	n = 13	17	
A. pseudoplatanus L.	Nainital, 1950, W	3—4	n = 26	18	2n = 52: TAYLOR, 1920; FOSTER, 1933.
HIPPOCASTANACEAE					
Aesculus indica COLEBR.	Shillong, Lake garden, 1500, E (Cultivated) Nainital, 1950, W	3—4; 9—10	n = 20	19	n = 20: MEHRA and SINGH, 1962; RAO, 1967.
A. assamica GRIFF.	K. & J. hills, Nongpoh, 800, E	3—4; 5—9	n = 20	20	2n = 40: ARORA, 1961.
SAPINDACEAE					
Sapindus detergens ROXB.	Darjeeling, Badamtam, 1000, E Nainital, Jeolikote, 1400, W	4—5; 9—11	n = 15	21	
S. attenuatus WALL.	Shillong, Botanical garden, 1500, E	4—5; 8—10	n = 15	22	
Euphoria longana LAMK.	K. & J. hills, Shella, 300, E	4—5; 8—10	n = 15	23	n = 15; 2n = 30: GUERVIN, 1961 a, BAHADURI and BOSE, 1949.
Nephelium litchi CAMB.	Darjeeling, Sukna, 150, E	3—4; 7—9	n = 15	24	n = 14: CHAUDHURI, 1940. 2n = 30: JANAKI-AMMAL in DARLINGTON and WYLIE, 1955.

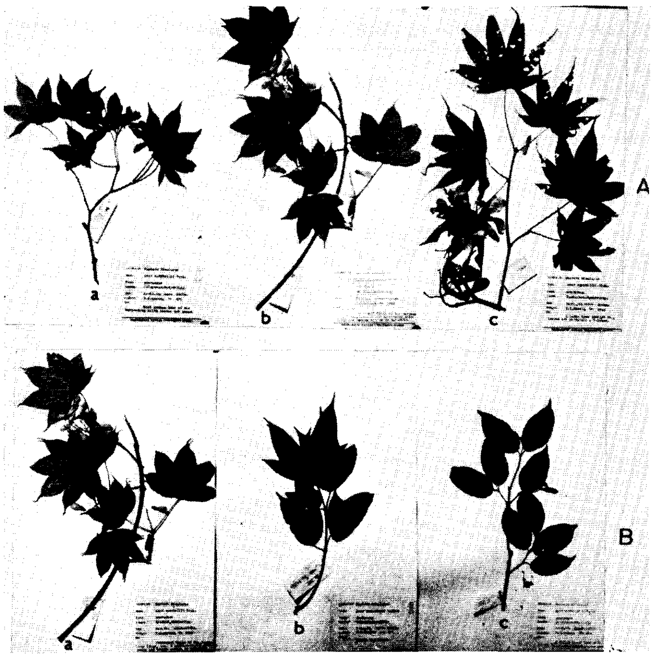


Fig. A: Heterophylly in *Acer campbellii;* (a) intermediate type, (b) taxon corresponding to var. *campbellii,* (c) taxon corresponding to var. *serratifolia.* — *Fig. B:* Branch of *Acer campbellii* (a), *A. osmastoni* (b), *A. laevigatum* (c).

mediate characters exhibit 45% pollen sterility probably revealing its hybrid nature.

A. osmastoni is distributed in the Darjeeling and Sikkim Himalayas from 1600—2600 m. The species is not common and usually thrives in patches in the valleys where *A. campbellii* and *A. leavigatum* form dominant element of the montane wet temperate forests. Trees attain height of 25—30 m. with girth 2.5—3.5 m. Leaves show heterophylly, the number of lobes vary from 0—3 even on the same branch. However, 5-lobed condition is not an exception in certain trees. The leaf morphology suggests the species to be a hybrid between *A. campbellii* and *A. laevigatum (Fig. B).* The lobed leaves closely resemble the former species while the entire leaves are similar to those of the latter. The distribution pattern of the species, occurrence only in those restricted localities where its putative parental species form dominant component of the vegetation, also provides evidence in favour of its hybrid origin. The flowering season of these three species at the same time in the year lends additional support to its hybrid nature. Cytologically, the species shows n = 13 *(Fig. 6)* with normal meiosis and 40% deformed and unstainable pollen. The high pollen sterility probably reveals its hybrid nature. Similarly Foster (1933) concluded that the high percentage of the pollen sterility in maples indicates a possible hybrid origin of many species.

A. villosum is a deciduous tree spread all along the Himalayas between 2100—2800 m. The species is of cytological interest. Meiotic studies have been made on materials from two distant places. Thirteen bivalents are counted at M-I in Rimbak population, E. Himalayas. Nainital population, W. Himalayas, reveals the gametic number to be 13 with 0-2B chromosomes. When 2 B's are present they are unpaired at diakinesis but show regular segregation at A-I. *Fig.* 7 shows 13 chromosomes and IB at each pole of P.M.C. at M-I. Forty-two P.M.C.'s have been examined. Eighteen cells are without any supernumerary, 9 have 1B while 15 are with 2B's. The presence of B chromosomes in the Nainital trees do not lead to any noticeable morphological differences.

To-date the cytology of about 50 species of the genus *Acer* is known. This includes 14 species and a variety currently investigated for the first time. Although the genus is highly polymorphic, variability among the species and within the species has had no effect on the basic set of 13 chromosomes. Meurmann (1933) on the basis of secondary pairing thought it to be a balanced set, derived from an ancestral complement of 12 chromosomes. No such indication is observed in the taxa studied by the authors.

All the 15 Himalayan species as also two introduced ones are diploid. *A. pseudoplatanus,* cultivated at Nainital, is tetraploid. In addition to this, polyploidy has been so far reported only in 3 other species, namely, *A. caprinifolium, A. saccharinum* and *A. rubrum* (cf Santamour, 1965). This brings the frequency of polyploidy in *Acer* to about 12%. Meurmann (l.c.) detected one triploid seedling of *A. platanoides. A. rubrum* displays various degree of polyploidy and aneuploidy with n = 36, 39, 40, 46, Ca.50, 52, 54, 68—75, 72, Ca.78, Ca.104, and 2n = 97, 98 (Taylor, 1920; Darling, 1923; Duffield, 1943; Wright 1957 and Santamour, l.c.).

(Continued from Table 1)

Name	Locality with altitude in meters	Flowering and fruiting season	Chromosome number	Fig. No.	Previous reports
Xerospermum noronhianum Bl.	K. & J. hills, Shella, 300, E	4—5; 11—12	n = 16	25	
Erioglossum rubiginosum Bl.	K. & J. hills, Shella, 300, E	3—4; 5—6	n = 13	26	
Dobinea vulgaris Hamilt.	Darjeeling, Jalapahar, 2300, E	9—10; 10—12	n = 7	27	
Dodonea viscosa (L.) Jacq.	Darjeeling, Teesta, 300, E	8—9; 11—12	n = 14	28	2n = 28: Miège, 1960. 2n = 30: Guervin, 1961 b. 2n = 32: Ahuja and Natrajan, 1957.
STAPHYLEACEAE					
Turpinia pomifera DC.	Darjeeling, Kalijohra, 300, E	1—3; 5—7	n = 13	29	
T. cochinchinensis (Lour.) Merr.	Kalimpong, Risum, 1200, E	3—5; 6—8	n = 13	30	

HIPPOCASTANACEAE:

This small family includes two genera, *Aesculus* and *Billia*, with 15 species which are natives of N. and S. America. *Aesculus indica* and *A. assamica* are the Indian representatives. The former is confined to W. Himalayas and the latter to E. Himalayas and K. & J. hills. *A. hippocastanum* is said to be indigenous to N. India but is not found wild (HOOKER, l.c.). *A. indica* is a timber of commercial recognition while *A. assamica* is locally exploited in K. & J. hills.

Both *A. indica* and *A. assamica* show uniformally n = 20. HOAR (1927) pointed to the hybrid constitution of the genus *Aesculus*. The observation of laggards and pollen sterility, secondary pairing and occasional quadrivalent formation in *A. hippocastanum* led UPCOTT (1936) to regard it as tetraploid on x = 10. LÖVE and LÖVE (1961) adopted x = 10 while DARLINGTON and WYLIE (1955) and GUSTAFSSON (1960) took 20 as the base number of the genus. Since minimum gametic number recorded till today for *Aesculus* is 20, the possibility of this as its base number is more probable. On the said grounds the presently studied taxa are at diploid level.

SAPINDACEAE:

Two thousand species included in 150 woody genera constitute the family *Sapindaceae*. These are pantropical in distribution with a few extensions into warm temperate areas. The family encompasses valuable timbers in Australia, but it is not so important elsewhere. Only two species are included among commercial timbers of India. The fruits of several species of *Sapindus* yield substitute for soap.

Sapindus is a primarily tropical genus of 13 species. *S. detergens* is apparently indigenous to N. India and cultivated upto 1500 m. The trees are tall in the Darjeeling area 20—30 m. high but small (upto 12 m.) in the K. & J. hills. Some difference is noticeable in the size of 15 bivalents at M-I *(Fig. 21)* in both E. & W. Himalayan taxa. Likewise, *S. attenuatus* also shows n = 15 *(Fig. 22)*.

The genus *Nephelium* comprises 35 Indo-Malayan species. *N. litchi*, a native of S. E. Asia is widely cultivated throughout the tropics for its edible fruit. At M-I, 15 bivalents are clearly seen *(Fig. 24)*. The species seems to exist as two aneuploid cytotypes with n = 15 (JANAKI-AMMAL in DARLINGTON and WYLIE, l.c.; authors) and n = 14 (CHAUDHURI, 1940). Further deviation from these chromosome numbers is published in *N. lappaceum* with n = 11 (RAMIREZ, 1961). Obviously, it is difficult to conclude the original base number of the genus.

Xerospermum embraces 20—25 S.E. Asian species distributed in the Malay Archipelago. *X. noronhianum* is the sole member of the genus in India. P.M.C. shows 16 bivalents at M-I in *Fig. 25*. The genus is cytologically unpublished earlier. Sixteen is suggested as its base number.

The monotypic genus *Erioglossum* is reported from the Indo-Malayan region and Australia. *E. rubiginosum* with n = 13 *(Fig. 26)* is the first chromosomal observation on the genus.

Dobinea is a small genus of two species met in the Himalayas and S. China. *Fig. 27* shows 7 bivalents and a nucleolus in *D. vulgaris*. Seven is suggested as the basic number of the genus which is previously unworked cytologically.

The genus *Dodonea* with its 60 species is mainly Australian in distribution. *D. viscosa* is a common hedge plant in N. India. The species is extremely variable morphologically with respect to the shape and size of the leaf, size of the capsules and shape of the seeds. SHREFF (1925) recognised 3 varieties. Both dioecism and monoecism have been recorded. The species is interesting cytologically too. Three aneuploid races have been established which show gametic numbers of 14 (MIÉGE, 1960; authors), 15 (GUERVIN, 1961 b) and 16 (AHUJA and NATRAJAN ,1957). GUERVIN (l.c.) determined 2n = 30 for *D. viscosa* var. *purpurea*, *D. attenuata* and *D. triquetra*, thereby emphasising 15 as the base number for the genus and further opined the derivation of x = 14, and 16 from this number through aneuploidy.

A perusal of the previous and present findings reveals that nearly 40 chromosomally known species show series of x = 7, 10—16, thereby, implying that aneuploidy has played a significant role in the evolution of the family. Since seven is the lowest haploid number recorded in the primitive genus *Dobinea* of the family, it may be the original base number of *Sapindaceae* and other numbers having evolved from this number by the process of aneuploidy or hypo- or hyper-ploidy.

STAPHYLEACEAE:

This small family with 5 genera and 60 species is chiefly represented in the Northern hemisphere. Two genera, *Staphylea* and *Turpinia* are met in India. To the genus *Turpinia* belong 30—40 species scattered in the tropics of Asia and America. *T. pomifera (Fig. 29)* and *T. cochinchinensis (Fig. 30)*, each with n = 13, are the first chromosomal reports for the genus for which 13 is suggested as the base number. These findings are in line with FOSTER's (l.c.) conclusions of x = 13 for *Staphylea*, the only other cytologically known genus of the family.

Conclusions

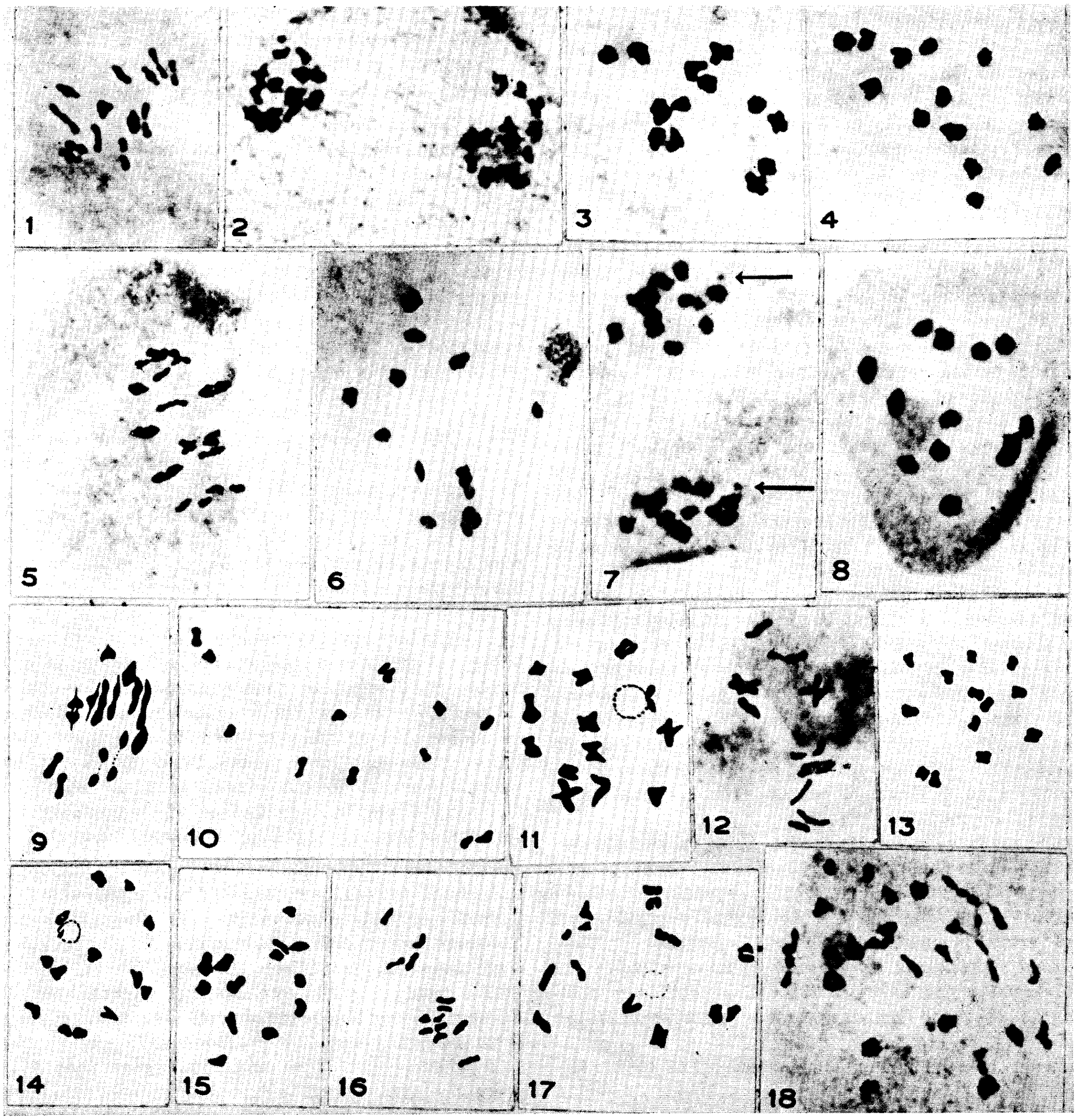
Chromosome size: Without exception all the woody species investigated here possess small chromosomes. A review of the literature reveals that small size of the chromosomes is characteristic of a vast majority of the woody angiosperms in general. The exclusively woody families like *Magnoliaceae*, *Sabiaceae* and *Combretaceae* are endowed with relatively large chromosomes. This overall situation thereby, implies that size of the chromosomes is only an attribute of certain families and orders but does not show any precise relationship with the phylogeny of angiosperms as a whole. Similar view point has been expressed by STEBBINS (1938).

One of the reasons for the small size of chromosomes in angiospermous trees may be their ancient polyploid origin, since most tree genera have high base numbers which have undoubtedly arisen from low base numbers through polyploidy. It is known that polyploidy is often correlated with the reduction in chromosome size.

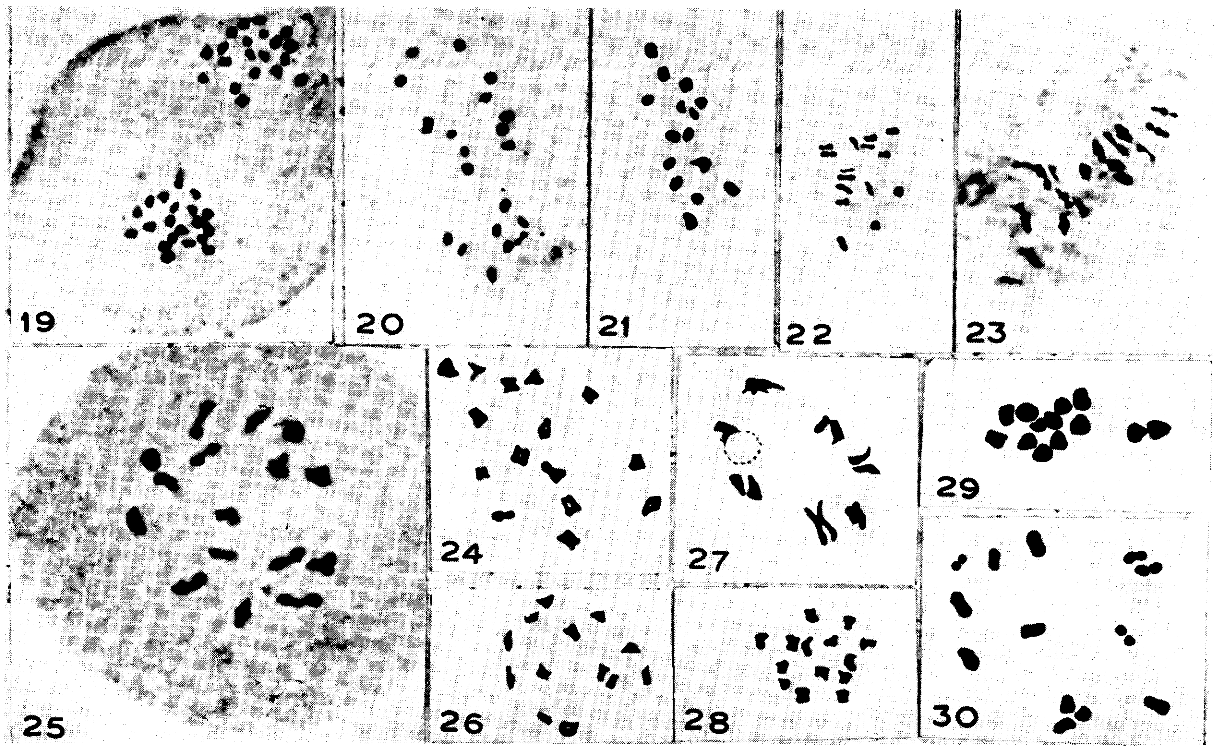
Base number: The base numbers encountered in the genera embodying the text are, *Acer* (x = 13), *Aesculus* (x = 20), *Sapindus* (x = 15), *Euphoria* (x = 15), *Erioglossum* (x = 13), *Xerospermum* (x = 16), *Dobinea* (x = 7), *Turpinia* (x = 13), *Nephelium* (11, 14, 15) and *Dodonea* (x = 14, 15, 16). The lowest basic set is 7 in *Dobinea*. The original base number for angiosperms has been inferred to be x = 7 (DARLINGTON, 1956; RAVEN and KYHOS, 1965), x = 6—8 (STEBBINS, 1950), x = 7—9 (GRANT, 1963). The numbers higher than 7 in the presently investigated genera might have originated by appropriate combinations of addition and substraction of chromosomes to the ancestral complement of 7. Leaving aside, *Nephelium* and *Dodonea* which are tribasic, other 8 genera are monobasic. This constancy in base number is depicted in great majority of the woody genera documented in literature. It seems that genomic functioning is so delicately balanced in the tree species that any change in chromosome number upsets the balance and acts adversely.

Polyploidy: In the present work, 29 species are diploid. One species, *A. pseudoplatanus*, an exotic, is tetraploid. This estimates the frequency of polyploidy to only 3.3% which is significant as compared to the percentage of polyploidy in angiosperms in general (30—35%: STEBBINS, 1950; TISCHLER, 1950; DEWOLF, 1957). The poor incidence of polyploidy in woody angisperms has been earlier pointed out by various authors. The capacity to form polyploids is variable in tree genera. The differences in potentialities of different genera to form polyploids is determined by their genetic nature (MORTON, 1966), some are more prone others less. It is likely that complete lack of polyploidy in the presently worked out Himalayan natives is due to the inherent poor tendency of the genera and even the families, to which they belong, to form polyploids. In all probability repatterning of chromosomes and gene mutations might have been of primary concern in delimiting species of such hardwood genera where polyploidy is either altogether absent or rare.

Meiotic behaviour: All the forms presently studied show normal course of meiosis. They possess small chromosomes which will have low chiasma frequency as such chromosomal aberrations of small magnitude may be present but not detectable. Putative natural hybrids like *Acer osmastoni* and a form of *A. campbellii* with characters intermediate between variety *serratifolia* and variety *campbellii* exhibit



Figs. 1—18. — Acer oblongum, Fig. 1: M-I showing 13 bivalents. — *A. caesium, Fig. 2:* A-I showing 13 chromosomes at each pole. — *A. thomsoni, Fig. 3:* M-I displaying 13 bivalents. — *A. campbellii, Fig. 4:* M-I showing 13 bivalents. — *A. pictum, Fig. 5:* M-I indicating 13 bivalents, a few showing early disjunction. — *A. osmastoni, Fig. 6:* M-I having 13 bivalents. — *A. villosum, Fig. 7:* A-I with 13 chromosomes + 1B at each pole. — *A. niveum, Fig. 8:* Diakinesis showing 13 bivalents, and a nucleolus. — *A. caudatum, Fig. 9:* M-I with 13 bivalents, 3 bivalents showing early disjunction. — *A. hookeri, Fig. 10:* M-I showing 13 bivalents. — *A. pectinatum, Fig. 11:* Diakinesis with 13 bivalents and a nucleolus. — *A. laevigatum, Fig 12:* M-I showing 13 bivalents. — *A. sikkimense, Fig. 13:* M-I containing 13 bivalents. — *A. papilio, Fig. 14:* Diakinesis displaying 13 bivalents with one bivalent attached to the nucleolus. — *A. stachyphyllum, Fig. 15:* M-I showing 13 bivalents. — *A. japonicum, Fig. 16:* M-I showing 13 bivalents. — *A. palmatum* var. *versicolor, Fig. 17:* Diakinesis showing 13 bivalents and a nucleolus. — *A. pseudoplatanus, Fig. 18:* Diakinesis with 26 bivalents and a nucleolus.



Figs. 19—30. — *Aesculus indica, Fig. 19:* A-I showing 20 : 20 disjunction. — *A. assamica, Fig. 20:* M-I showing 20 bivalents. — *Sapindus detergens, Fig. 21:* M-I containing 15 bivalents. — *S. attenuatus, Fig. 22:* M-I with 15 bivalents. — *Euphoria longana, Fig. 23:* M-I showing 15 bivalents. — *Nephelium litchi, Fig. 24:* M-I showing 15 bivalents. — *Xerospermum noronhianum, Fig. 25:* M-I showing 16 bivalents. — *Erioglossum rubiginosum, Fig. 26:* M-I displaying 13 bivalents. — *Dobinea vulgaris, Fig. 27:* Diakinesis showing 7 bivalents, one bivalent attached to the nucleolus. — *Dodonea viscosa, Fig. 28:* M-I indicating 14 bivalents. — *Turpinia pomifera, Fig. 29:* M-I showing 13 bivalents. — *T. cochinchinensis, Fig. 30:* M-I showing 13 bivalents, 3 bivalents showing early disjunction.

normal meiosis at diploid level, a situation parallel to that of some other hardwood genera like *Fraxinus, Quercus* and *Populus.* Stebbins (1938) concluded that cytological stability in woody genera favour regular meiotic behaviour in hybrids.

Accessory chromosomes: Since their first detection in plants in *Zea mays* by Longley (1927), accessory chromosomes have been reported in number of species. Darlington (1956) states that hundreds of plants possess them but they are absent in trees. Davis and Heywood (1963) pointed out that B-chromosomes are unknown in the long-lived woody plants. The present account reveals B-chromosomes in only one arboreal species, *Acer villosum* (Nainital). Earlier, Mehra and Bawa (1968) have reported the occurrence of B-chromosomes in 6 species of Himalayan hardwoods.

Systematics: Four families included in the text have been treated under one family *Sapindaceae* in the "Genera Plantarum" of Bentham and Hooker (1862—1883). Radlkofer (1869) segregated the parent family *Sapindaceae* of Bentham and Hooker (l.c.) into fourteen tribes of which, *Aceraceae, Hippocastanaceae,* and *Staphyleaceae* have been given the family rank by modern taxonomists. The constancy of base number in *Aceraceae* (x = 13), *Hippocastanaceae* (x = 20) and *Staphyleaceae* (x = 13) cytologically substantiates the separation of these families from the allied family *Sapindaceae* which presents polymorphicity of the chromosomal condition with x = 7, 10—16. The identical base number 13 in *Aceraceae* and *Staphyleaceae* is a cytological expression of the close relationship between these two families.

Acknowledgements

We are sincerely thankful to the sponsoring authorities of the U. S. Government for financial help under PL 480 Grant A7-FS-12.

Summary

Cytological studies of 30 hardwood species from the Himalayas have been carried out. Of these, 18 belong to *Aceraceae,* 2 to *Hippocastanaceae,* 8 to *Sapindaceae* and 2 to *Staphyleaceae.* Four genera namely, *Xerospermum* (x = 16), *Erioglossum* (x = 13), *Dobinea* (x = 7) and *Turpinia* (x = 13) have been worked out for the first time. New chromosome reports have been made available for 21 species and a variety.

Aesculus indica (n = 20), *Acer oblongum* (n = 13), *A. caesium* (n = 13), *A. thomsoni* (n = 13), *A. campbellii* (n = 13) and *A. pictum* (n = 13) are species of commercial timbers.

Small chromosomes and normal meiotic behaviour are characteristic of all presently studied species.

Monobasic chromosomal constitution is noticed in 8 genera. Two genera are tribasic namely, *Nephelium* (x = 11, 14, 15) and *Dodonea* (x = 14, 15, 16). Uniformity of base number is observed in *Aceraceae* (x = 13), *Hippocastanaceae* (x = 20) and *Staphyleaceae* (x = 13) which lend cytological support for their separation from *Sapindaceae* (x = 7, 10—16) of Bentham and Hooker (1862—1883). Seven has been considered to be the original base number of the family *Sapindaceae.*

Twenty-nine species are diploid as aginst one tetraploid which is an introduced species (3.3% polyploidy).

Acer osmastonii is a putative hybrid between *A. campbellii* and *A. laevigatum* as indicated by leaf morphology, geographical distribution, flowering time and high pollen sterility. *A. campbellii* with its two varieties namely, *campbellii* and *serratifolia* presents intermediate populations, possibly derived through hybridization.

Nainital trees of *Acer villosum* possess 0-2 B's, but morphologically look like those of Rimbak population (Derjeeling) without B's.

Zusammenfassung

30 Hartholz-Arten aus dem Himalaja (18 der *Aceraceae*, 2 der *Hippocastanaceae*, 8 der *Sapindaceae* und 2 der *Staphyleaceae)* wurden zytologisch untersucht. Alle Arten besitzen kleine Chromosomen und zeigen eine normale Meiose. — 8 Gattungen haben nur 1 Chromosomengrundzahl, 2 Gattungen haben 3 Grundzahlen. — Eine einheitliche Chromosomengrundzahl wurde gefunden bei den *Aceraceae* (x = 13), den *Hippocastanaceae* (x = 20) und den *Staphyleaceae* (x = 13). Diese Tatsache trennt diese Familien von der Familie der *Sapindaceae*, die x = 7, 10—16 Chromosomen hat. — *Acer osmastonii* ist als Bastard zwischen *A. campbellii* und *A. laevigatum* anzusehen, wofür die Blattmorphologie, die geographische Verbreitung, die Blütezeit und die hohe Pollensterilität sprechen. — Bei *Acer villosum* besitzen die Bäume von Nainital 0 bis 2 B-Chromosomen, unterscheiden sich aber morphologisch nicht von der übrigen Population, die diese nicht hat.

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Cytomorphology of Himalayan Fagaceae

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(Received May 1971)

Introduction

The *Fagaceae* represents the most important source of timber among the broad leaved species of Northern hemisphere. *Fagus, Castanea* and *Quercus* are the significant genera in this respect, the last excelling conifers in the number of species and importance in certain areas. The oak wood has been regarded as invaluable for its strength, durability (even under water) and alround usefulness. *Quercus alba, Q. borealis* in U.S.A. and *Q. robur, Q. sessiliflora* in the British Isles and Southern Europe are the important timber species. *Quercus suber* and its variety *occidentalis* are the chief sources of commercial cork from the Mediterranean. Some of the scrubby *Quercus* species in the arid regions help to control soil erosion.

The family comprises 8 genera and 900 species (Willis, 1966). It is best represented in North America where largest number of species thrive, while Europe and Asia rank second and third respectively. King (1889) has given an illustrated account of 82 species of *Quercus* and 22 species of *Castanopsis* from the Indo-Malayan region. Hooker (1885) described 58 species of *Quercus* and 16 species of *Castanopsis* in his 'Flora of British India'. He treated these genera under tribe Quercineae of the Order Cupuliferae. The species of *Quercus* were described under different sections based chiefly on the character of leaves (entire or serrate and lobed), nature of male spikes (pendulous or erect), shape of fruit and arrangement of scales of the cupule (imbricate or zonate). Some of these sections

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