

VARIATION IN *PODOPHYLLUM HEXANDRUM* L. (PODOPHYLLACEAE)
IN HIMALAYA

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ABSTRACT

Present study deals with the variation pattern among the populations of *Podophyllum hexandrum* L. Both intra- as well as inter population variation mainly in height of plants, length of internodes, length of petioles, leaf incision, margins and pubescence, length of pedicels, colour of flowers, size of fruits and number of seeds have been observed. Some of these variations are continuous and unstable. The variety *P. hexandrum* var. *jaeschkei* has been reduced here as synonym under *P. hexandrum* for the first time.

INTRODUCTION

The genus *PODOPHYLLUM* L. consists of ca 6 species distributed over Afghanistan, Pakistan, India, Nepal, Bhutan, China to E. Asia and N. America (Rao and Hajra, 1993). In India the genus is represented by only two species namely *P. hexandrum* Royle and *P. sikkimensis* Chatterjee & Mukerjee which are confined to the Himalayan region. Of these, *P. sikkimensis* Chatterjee & Mukerjee is endemic to N.E. Himalaya (Sikkim) whereas *P. hexandrum* Royle shows a scattered distribution throughout Himalaya.

Podophyllum hexandrum Royle is a perennial erect herbaceous plant with rhizomatous rootstock. The plants grow on open hill slopes, shady moist places, open pastures, meadows and rocky places in temperate broad leaved and coniferous forests at 1800 to 4200 m above m.s.l. The species flowers during May-June and fruits during July to September. The aerial portion is annual thriving up to mid November.

P. hexandrum is a highly variable species and due to its polymorphic nature a number of infraspecific taxa are recognised (Chatterjee, 1952, 1953), indicating the extent of variation within this species. Chatterjee (1953) described 4 varieties under *P. emodi* Wall. ex Honigberger. Synonym of *P. hexandrum* (Soejarto *et al.*, 1979) based on morphological characters such as plant height, petiole length, lobing and serration of leaf, position of pedicel etc. These are *P. emodi* var. *hexandrum* (Royle) Chatterjee & Mukerjee, *P. emodi* var. *axillaris* Chatterjee & Mukerjee, *P. emodi* var. *bhootanensis* Chatterjee & Mukerjee and *P. emodi* var. *jaeschkei* Chatterjee & Mukerjee. Hara (1979) and Grierson and Long (1984) reduced the varieties *P. hexandrum* var. *axillaris* Chatterjee & Mukerjee and *P. hexandrum* var. *bhootanensis* Chatterjee & Mukerjee under *P. hexandrum* Royle. Jafri (1974) also states that *P. hexandrum* Royle is a very variable species and doubted separation of taxa. Recently, Rao and Hajra (1993) working for Flora of India excluded the varieties

axillaris Chatterjee & Mukerjee and *jaeschkei* Chatterjee & Mukerjee from Indian flora but without clarifying the correct position of these taxa. *Podophyllum hexandrum* thus requires study of variations for clarifying the confusion in the taxonomy of the species.

Populations of *PODOPHYLLUM* throughout its range are declining. Some of the populations are represented by even less than 20 individuals. But in certain areas of Ladakh (Kargil to Panikhar, Samkeo), Kashmir (Gulmarg) and Lahul (Koksar, Kardang) larger populations can be found. The aim of the present work is to assess the pattern of variation in some of the characters to arrive at a more realistic taxonomic treatment and clarify the limits of natural groups.

MATERIALS AND METHODS

The present study is based on field observations (Living plants) as well as scrutiny of herbarium specimens deposited at different herbaria (LWG, CAL, BSD, DD). More than 150 plant specimens have been critically studied for assessing the extent of diversity within the populations. The populations studied have been shown in the *Table-1*. Measurements and illustrations are based on specimens, vouchers of which are mentioned appropriately.

RESULTS AND DISCUSSION

Habit : *Podophyllum hexandrum* is an erect herbaceous plant with rhizomatous rootstock. The underground portion (rhizomatous rootstock) of the plant is perennial while the aerial portion is annual. The height of the plants varies (10 to 59 cm) considerably both within the among different populations. The dwarf form is found in populations of Baspa valley (K.P. Janardhanan 47423), Dalhousie (M.A. Rao 2450), Kumlaon (T.A. Rao 7051) and longest plants in Ladakh (M.V. Viswanathan 55676). Often the dwarf forms are treated as a

distinct variety. However, the variation in the height of plant is continuous with all intermediate forms and hence the creation of a variety for the dwarf form (var. *jaeschkei* Chatterjee & Mukerjee) is not justified.

Root : The roots are rhizomatous and creeping giving to annual herbaceous aerial portion every year. The shape and size of the rootstocks show relatively little variation in different populations. The thick numerous fibrous roots arise from the rhizomatous portion penetrating deep in the soil. The length of fibrous root often reaches up to 42 cm.

Scales : The scales are found at the top of the rhizomatous rootstock surrounding the basal portions of the stem. The scales are narrowly ovate with entire margin and acute tip, membranous and pale in colour. The length of scales vary from 0.5 to 6 cm long.

Stems : The annual stem is erect, fleshy/succulent and terete with smooth surface, unbranched, bearing 2-3 alternate leaves in upper portion. In some populations of Kashmir (Baisaran, T.A. Rao 582) the stem bears only one leaf without any other variation. On drying, the stem appears to be striate. Generally, the stem is glabrous while in some plants from Kashmir it is finely woolly pubescent. In some other populations from Kashmir (Khailang Marg, G.S. Srivastava 10678) a few scattered pilose hairs are intermixed with fine woolly hairs. The length of internodes on stem is extremely variable both within and among different populations (Fig. 1A-K). Only 1 or 2 internodes are present varying from 0.2 to 14 cm long. Sometimes due to extreme reduction of the internodes the leaves appear opposite and flowers axillary in some of the populations from Lahul, Kalatop, Kedarkanta, Deoban and Gulmarg (Fig. 1A,B). The Uppermost internode is always shorter than lower ones but occasionally in some population (Uttarkashi,

U.C. Bhattacharyya 74768) the lower most internodes is extremely shorter than the upper ones (Fig. 1C).

Leaves : The leaves also exhibit remarkable intra-as well as inter population variations, especially in size, incision and serration of margins. They are distinctly petioled and alternately arranged in all populations. Sometimes the leaves appear opposite with axillary flower due to reduction of internodes. These variant forms are given varietal status (var. *axillaris*) by Chatterjee (1953). But the variations are continuous occurring within even the same population (Fig. 1 A-K) and hence a varietal status is not justified.

The lamina *P. hexandrum* is constantly palmately 3-lobed/incised, more or less peltate. Often they appear 5-lobed due to deep incision of lateral lobes. The variations in number and lobation of leaves in different populations studied are shown in Fig. 2A,H. The individual lobe in 3-lobed forms is typically broad and serrate only along upper margins (Fig. 2A), but in other forms they are often 2-3 lobulate. Sometimes in some individuals of Ladakh population the middle lobe is undivided (Fig. 2D). The incision of lateral lobes is always deep (up to the base) than middle ones in which it is only up to middle. Again, the shape, size and breadth of lobes and lobulates vary among different populations.

The leaf margin shows much variation even within the same population. Usually the margins are serrate while in some population of Ghangaria (*U.C. Bhattacharyya* 66393), Panwali (*A.K. Goel* 66643, 16583), Kashmir (*T.A. Rao* 7673), they are entire and in other population of Kashmir (Chandanwadi, *N.C. Nair* 36924) and Ladakh (*B.M. Wadhwa* 59839) they are dentate. Chatterjee (1953) has used this character for keying out the varieties under *P.*

hexandrum which is again not tenable.

The leaves also exhibit much variation in respect of pubescence character particularly on lower surface. The upper surface is uniformly glabrous in all plants while the lower surface vary glabrescent to densely hairy. The leaves with densely pubescent on lower surface are found in some populations of Ladakh (*B.M. Wadhwa* 58716), Lahul (*U.C. Bhattacharyya* 40693) and Almora (*Belapure & Pandey* 93371). Rarely in some population both surfaces are found glabrous. The hair types are finely woolly to pilose. Usually the hairs are adpressed while in some individual plants hairs are observed. The pilose hairs are single-celled and whiplash type with smooth surface.

The shape of leaf base is cordate and almost constant in all populations. Petioles also show variation in length from 1.3-15 cm long in intra as well as inter populations. The lower petioles are always longer than upper ones and very rarely as in some plants of Lahul (*S.P. Sethi & R.S. Negi* 380) the condition is opposite. Occasionally, in some populations of Sikkim (*G. King's Collector* s.n.) and Baspa (*K.P. Janardhanan* 52780) the length of upper petioles is very short and hence the position of pedicel becomes very close to the lamina (Fig. I,K). In general the petioles are terete in outline with smooth surface. The petioles are swollen at base in almost all plants.

Flowers : In *P. hexandrum* the flower is solitary, terminal or supra-axillary and always develop at the base of upper petiole. Sometimes due to reduction of internodes the position of flower appears axillary (Fig. 1A,B). The flowers are usually pink while in population of Baspa valley (Chitkul) they are white. The flower is distinctly pedicelled. The length of pedicel ranges from 1.0-5.5 cm. The pedicel is erect but deflexed in fruiting, glabrous and swollen at apex.

Perianth : The tepals show narrow range of variation throughout its range of distribution. Tepal number varies from 5-6. The shape of tepals is obovate with narrow base, entire margin and obtuse or rounded apex, faintly veined and deciduous at maturity.

Stamens : The stamens are usually 5-6 in number and deciduous after anthesis. Anthers are oblong or ovate with obtuse tips. They are usually straight while in some plants few are straight and others are slightly falcate. Filaments are filiform or flattened in some populations. The length of filament is almost equal to anther or rarely slightly longer than anther.

Ovary : Generally the ovary is glabrous while in some plants of Kashmir fine woolly hairs are found. The ovary is ellipsoid and sessile with few to numerous ovules inside. The stigma is broad and peltate and almost sessile (estylous).

Fruits : The shape of fruit varies from ellipsoid, oblong-ovoid, obovoid to almost rounded. The fruit size ranges from 2.8-6.0 cm $\times$ 2-5 cm. The larger size of the fruit is observed in one population of Kashmir (Bhadrawaha-Seoj). Mostly the fruits are pointed at both ends while in some plants of Lahul (N.C. Nair 1965) they are rounded (Fig. 3E). The surface is glabrous in all populations. But for the first time we could observe hairs on the ripe fruits in some of the plants from Kashmir (G. Saran & Party 21674).

Seeds : The seeds are ovoid, glabrous and brown. Their size ranges from 3-5 $\times$ 1.5-2.5 mm. The number of seeds varies from 11 to many in different populations.

NOMENCLATURE

Podophyllum hexandrum Royle, Ill. Bot. Himal. 64. 1834; Cambess. in Jacquen., Voy. Bot. 2:10, t.9. 1844; photo. Pl. E.

Himal. F. 216. 1968; Hara in Fl. E. Himal. 2 : 34. 1971 & in Hara & Williams, Enum. Flow. Pl. Nepal 2:31. 1979; Grierson & Long in Grierson & Long., Fl. Bhutan 328. 1984; Rao & Hajra in Sharma *et al.*, Fl. India 1:415. 1994. *P. emodi* Wall. (Cat. n. 814. 1829, *nom. nud.* : Royle, Ill. Bot. Himal. 64. 1834, *nom. nud.*) ex Honigberger, Thirtyfive years in the east 324, f. 20, 1852; Hook.f. & Thomson in Fl. India. 1:232. 1855, & in Fl. Brit. India 1:112, 1872; Chatterjee in Rec. Bot. Surv. India 16 : 44. 1953; Ahrendt in Candollea 15 : 155. 1956; Stewart, Ann. Catl. Vasc. Pl. W. Pakistan & Kashmir 282. 1972; Jafri in Nasir & Ali, Fl. W. Pakistan 57 : 1, f. 1A-C. 1974.

P. emodi var. *hexandrum* (Royle) Chatterjee & Mukerjee in Rec. Bot. Surv. India 16 : 45. 1953.

P. emodi var. *axillaris* Chatterjee & Mukerjee in Rec. Bot. Surv. India 16 : 46. 1953. *Type* : Teesta valley above Tangu, 13500 ft., 6.7.1903, Major Young Husband s.n. (CAL!).

P. emodi var. *jaeschkei* Chatterjee & Mukerjee in Rec. Bot. Surv. India 16 : 47. 1953. *Type* : Lahul, Jaeschke (CAL!).

P. emodi var. *bhootanensis* Chatterjee & Mukerjee in Rec. Bot. Surv. India 16 : 46. 1953. *Type* : Bhootan, Taloong, 2.8.1884, Dungboo 289 (CAL).

P. hexandrum var. *emodi* (Hook.f. & Thoms.) Selivana-Gorodkova in Novosti Sist. Vyssh. Rast. 12 : 209.

P. hexandrum var. *bhootanensis* (Chatterjee & Mukerjee) Browicz in Fl. Iran. Podoph. 2, in nota 1973.

Sinopodophyllum emodi (Honigberger) Ying in Acta Phytotax. Sin., 17(1) : 16. 1979
Fl. : May - June ; *Fr.* : July - Sept.

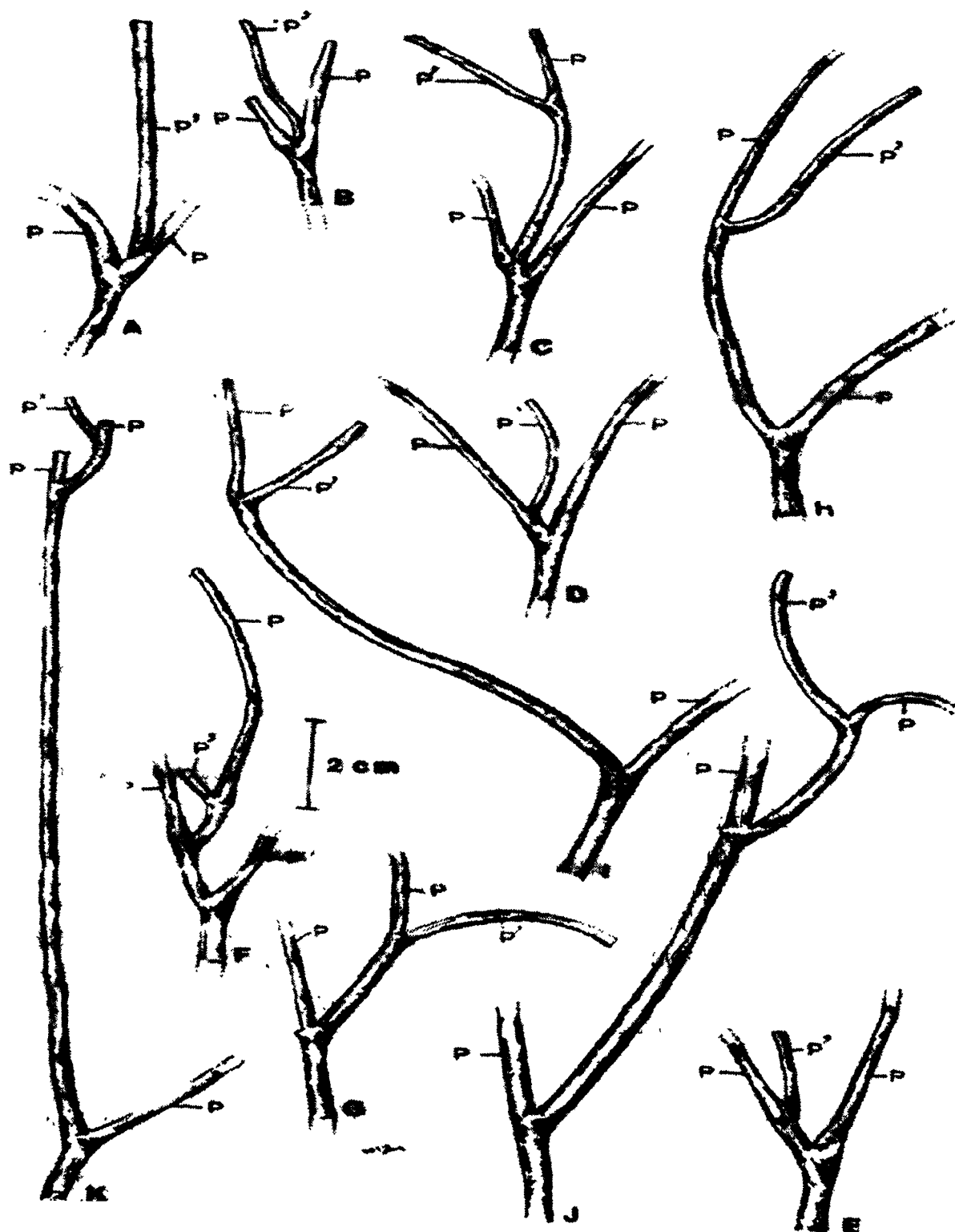


Fig. 1 : Geographical variation in the length of internode and position of pedicel. A. Lahul, J.R.R. 5303 ; B. Lahul, S.P. Sethi & R.S. Negi 380 ; C. Uttarkashi, U.C. Bhattacharyya 74768 ; D. Kalatop, C.L. Malhotra & V.J. Nair 27996 ; E. Kansar, T. A. Rao 9141 ; F. Pirpass, T.A. Rao 7673 ; G. Bashahr, N.C. Nair 34216 ; H. Chandanwadi, N.C. Nair 36924 ; I. Baspa valley, K.P. Janardhanan 52780 ; J. Lahul, N.C. Nair 16857 ; K. Sikkim, G. King's Collector s.n. (P = ptiloe, p' = pedicel).

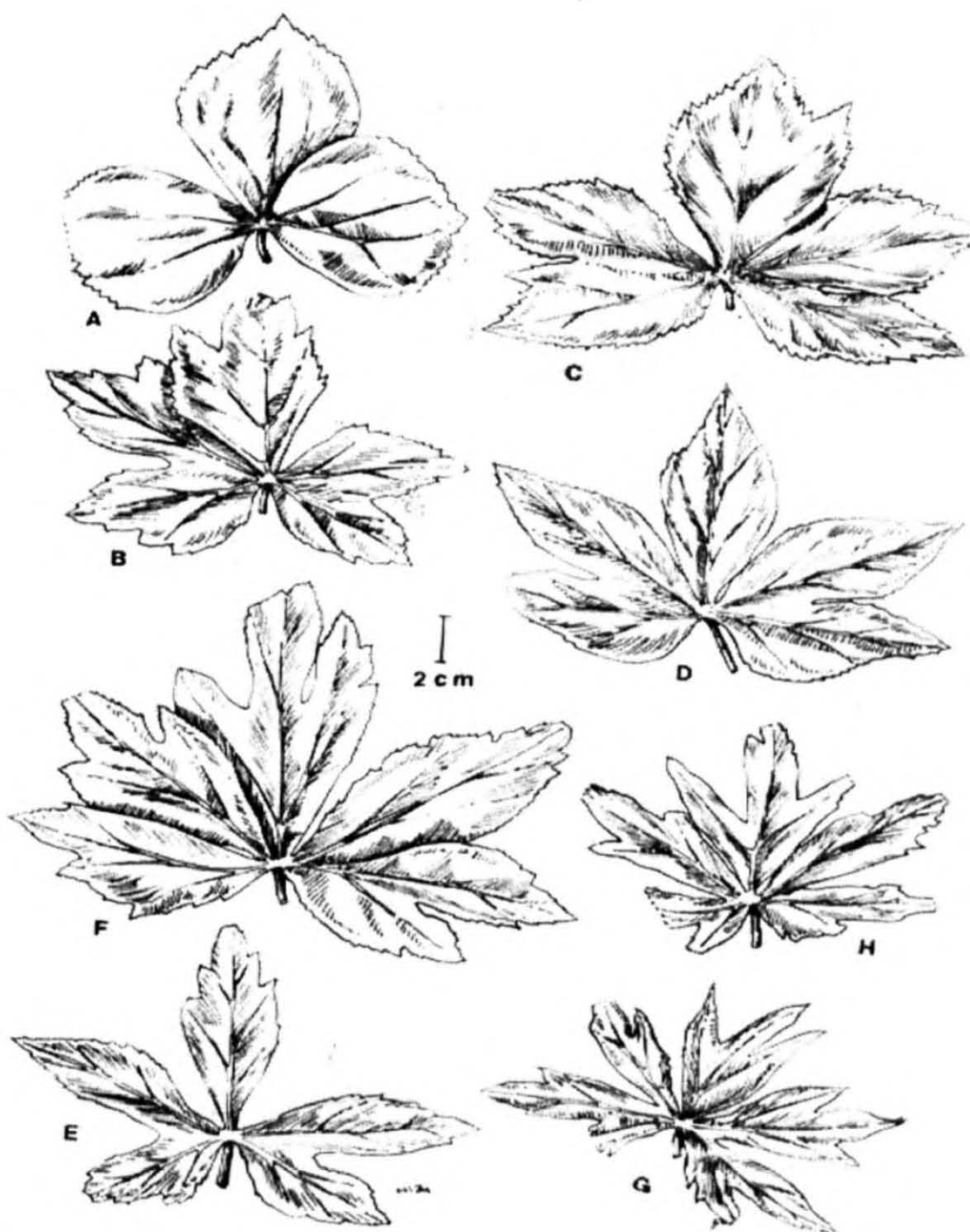


Fig. 2.: Geographical variation of leaves in shape and division. A. Baisaran, T.A. Rao 582 ; B. Dagwan, B.M. Wadhwa 66959 ; C. Chandanwadi, N.C. Nair 36924 ; D. Ladakh, B.M. Wadhwa 58716 ; E. Lahul, N.C. Nair 17054 ; F. Panwali, A.K. Goel 72822 ; G. Ghangaria, U.C. Bhattacharyya 66393 ; H. Pirpass, T.A. Rao 7673 ; I. Satrundi, N.C. Nair 32434.

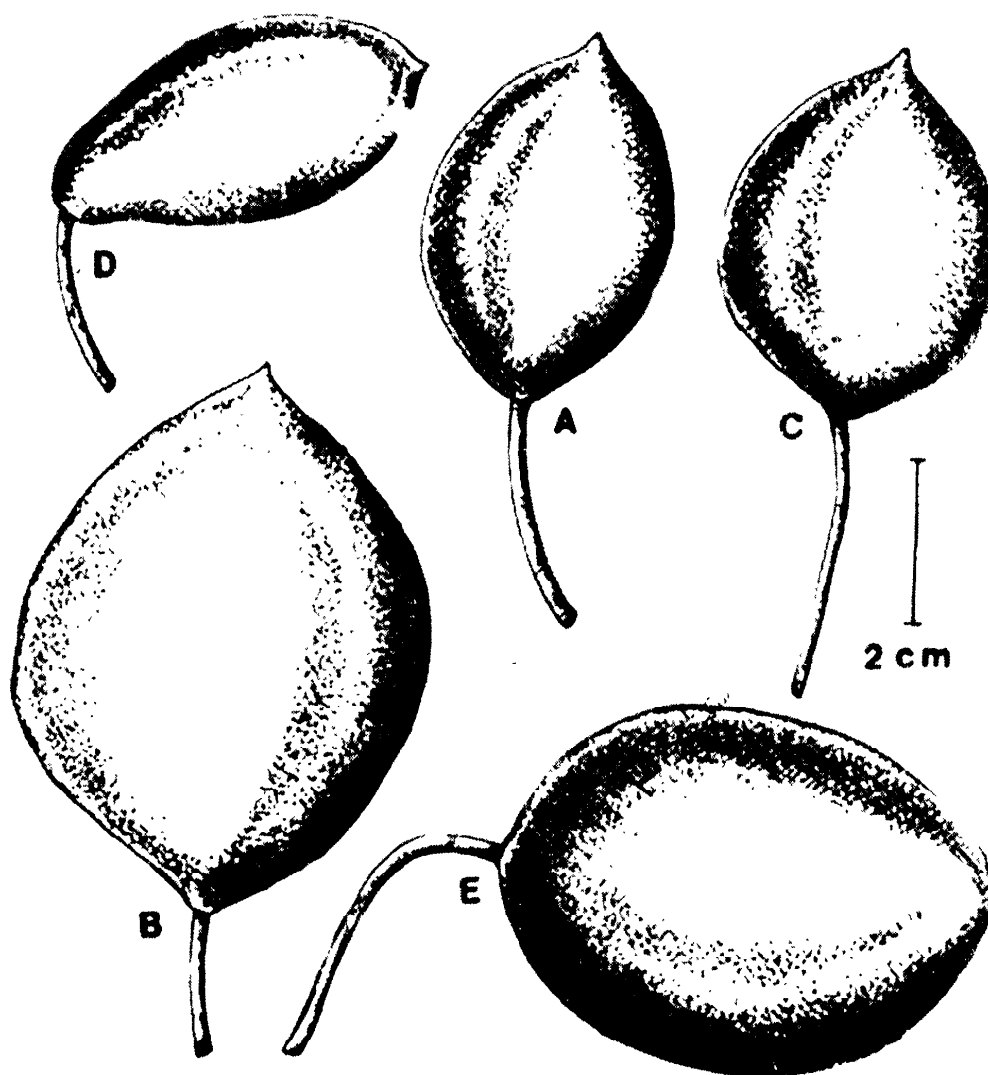


Fig. 3. Geographical variation of fruits in shape and size. A. Sheshnag, *M. A. Rao* 50310; B. Bhadrawaha-Soej, *J.N. Vohra*, & *B.D. Naithani* 83007; C. Ladakh, *H. J. Chowdhery* & *B. P. Uniyal* 85876; D. Lahul, *N.C. Nair* 17054; E. Lahul, *N.C. Nair* 16857.

Distrib. : INDIA : (Himalaya, Jammu & Kashmir, Himachal Pradesh, Uttar Pradesh, Sikkim, Arunachal Pradesh). Afghanistan, Pakistan, Nepal, Bhutan, China to E. Asia, N. America.

Ecology : As an undergrowth in temperate forests, mainly of *Quercus*, *Cedrus*, *Abies*, *Rhododendron* and open meadows.

Specimens examined : JAMMU & KASHMIR : Ladakh : Zojilla, *P.K. Hajra* 74013 (BSD) ; Zojilla, 11500 ft., *G.A. Gammie* s.n. (CAL); Kargil to Panikhar, *H.J. Chowdhery & B.P. Uniyal* 95876 (BSD); Dran Kargil, *B.M. Wadhwa* 58716 (BSD); Menchigaon on Kargil-Sune route, 3300 m, *M.V. Viswanathan* 55676 (BSD); Samkéo, 3100 m, *B.M. Wadhwa* 59838 (BSD); Bhadrawaha-Seoj. 3300 m, *J.N. Vohra & B.D. Naithani* 83007 (BSD) ; Gulmarg, 2800 m, *U.C. Bhattacharyya* 71192 (BSD); Gulmarg Fir forest, 9300 ft., *T.A. Rao* 237 (BSD); Gulmarg, 9000 ft., *G. Saran & Party* 31674 (LWG); Gulmarg, 9000 ft., *G.A. Gammie* s.n. (DD); Chandanwadi, 2900 m, *N.C. Nair* 36924 (LWG); Dagwan, *B.M. Wadhwa* 66959 (BSD) ; Waskar-Dagwan, 3500 m, *B.M. Wadhwa* 66896 (BSD); Jai/Kansar, *T.A. Rao* 9141 (BSD) ; Baisaran, 8700 ft., *T.A. Rao* 582 (BSD) ; Sheshnag, 3500 m, *M.V. Rao* 50310 (BSD, DD) ; Killang Marg, 9-10000 ft., *J.F. Duthie Coll.* s.n. (DD) ; Killang Marg, 9500 ft., *G.S. Srivastava* 10678 (LWG); Jhelum, Nag Marg, 8-9000 ft., *Keshavanand* 1787 (DD); Daitwas forest, Khinhama, 8-9000 ft., *Keshwanand* 949 (DD); Gilgit, Nattar Lakes, 12000 ft., *R.R. Stewart* 26403 (DD); Verinag hill, *K.N. Kaul & Party* 73721, 73732 (LWG); Jammu province, Simthan, *G. Saran & Party* 30331 (LWG) ; Sanasar, *B.K. Abrol* 3822 (LWG); Mughal Maidan, 10 miles from Kistwar towards Chhatru, 7500 ft., *G. Saran & Party* 30128 (LWG). HIMACHAL PRADESH. Lahul: Koksar, 3500 m, *U.C. Bhattacharyya*

48609 (BSD); Koksar, 11000 ft., *N.L. Bor* 12115 (DD); Keylang, Kardang, 3500 m, *U.C. Bhattacharyya* 40752 (BSD) ; Koksar, 3200 m, *U.C. Bhattacharyya* 51745 (BSD) ; Koksar, 3425 m, *N.C. Nair* 17054 (BSD) ; Chotadara, 2850 m, *N.C. Nair* 16857 (BSD) ; Sissoo, 2900 m, *U.C. Bhattacharyya* 40693 (BSD) ; Sissoo, *N.L. Bor* 9481 (DD) ; Kardang, 10000 ft., *S.P. Sethi & R.S. Negi* 380 (DD) ; Manali, 10000 ft., *N.L. Bor* 14468 (BSD) ; Baspa valley, Chitkul, ca-3425 m, *K.P. Janardhanan* 47423 (BSD) ; Rakcham, ca 3200 m, *K.P. Janardhanan* 47339 (BSD) ; Rakcham, *K.P. Janardhanan* 53549 (BSD); Chitkul, *K.P. Janardhanan* 52780 (BSD) ; Bashahr, Sanglakando, 3800 m, *N.C. Nair* 34216 (BSD); Harangote pass, 10800 ft., *U.V. Laurie* 5384 (DD) ; Bashahr, 3555 m, *N.C. Nair* 34408 (BSD); Danchoo, 3200 m, *B.M. Wadhwa* 53443 (BSD) ; Chamba State, Kalatop, 8000 ft., *J.H. Lace* 1314 (CAL) ; Kalatop 2500 m, *C.L. Malhotra & V.J. Nair* 27996 (BSD) ; Satrundi, 3600 m, *N.C. Nair* 32434 (BSD) ; Dalhousie, 3000 m, *T.A. Rao* 2540 (BSD) ; Kulu, Pulga. 8000 ft. *C. Purkayastha* s.n. (DD) ; Pulga, 11500 ft. *S.K. Jain & R.C. Bharadwaja* s.n. (DD). UTTAR PRADESH. Chamoli dist. : Ghangaria, *U.C. Bhattacharyya* 66393 (BSD); Ghangaria, *B.M. Wadhwa* 62447 (BSD) ; Hemkund, 3300 m, *M.A. Rao* 31768 (BSD) ; Ghangaria, 3000 m, *L.B. Chaudhary & A. Saklani* 213959 (LWG) ; Jumnotri, 3200 m, *M.A. Rao* 15761 (BSD) ; Panwali, 3500 m, *A.K. Goel* 72822 (BSD) ; Panwali, 4000 m, *A.K. Goel* 66583 (BSD); Panwali, 3100 m, *B.D. Naithani* 48160 (CAL) ; Kedarkanta, 10-11000 ft., *J.F. Duthie* 1022 (CAL) ; Konain, *R.S. Troup* 1(3)/1034 (DD) ; Dartmir, 10000 ft., *C.G. Rogers* s.n. (CAL) ; Kinani Pani, 8-9000 ft., *J.F. Duthie* 1022 (CAL); Deoban, 9000 ft., *U.N. Kanjilal* 511 (DD) ; Deoban, *C.S. Chand* 5 (CAL) ; Dwali Furkia, 3000-3500 m, *T.A. Rao* 4385 (BSD)

Furkia, 10700 ft., *N. Gill.* 826 (CAL) ;
 Sryakund, 4200 m, *T.A. Rao*, 7091 (BSD), *N.*
Milam Bugyal, 4000-5600 m, *T.A. Rao* 7051
 (BSD) ; Forest below the Panchchulli glacier,
K.C. Sahni 20436 (DD) ; Pindari Glacier, *B.*
Ram 2127 (DD) ; Near Pindari, 10500 ft., *R.*
Strachy and *J.E. Winterbottom* s.n. (CAL) ;
 Phurkia to Khati, 10300 ft., *Balapure & A.*

Poandey 93371 (LWG). SIKKIM : Changu,
 12000 ft., Rib & Rhomoo 4425 (CAL) ; Changu
 1200 ft. *W.W. Smith* 3276 (CAL) ; below
 Changu 13000 ft., *W.W. Smith* 3529 (CAL) ;
 Tchi-gook, 14000 ft., *G. King's Collector* s.n.
 (DD). ARUNACHAL PRADESH : NEFA 9 KF.D.,
 Sela-Zang, 13100 ft., *R.S. Rao* 7784 (CAL).

Table - 1 : Population of *Podophyllum hexandrum* in the Himalaya

	Locality	Number of Plants	Altitude above m.s.l.
1.	Ladakh	5	3100-3300 m
2.	Bhadrawaha	1	3300 m
3.	Gulmarg	3	2800 m
4.	Chandanwadi	1	2900 m
5.	Dagwan	2	3500 m
6.	Kansar	1	
7.	Baisaran	1	2610 m
8.	Sheshnag	2	3500 m
9.	Killang	2	2700-3000 m
10.	Jhelum valley	2	1800-2400 m
11.	Gilgit	1	3600 m
12.	Verinag	2	
13.	Jammu	3	2250 m
14.	Lahul	12	2900-3850 m
15.	Baspa valley	5	3200-3425 m
16.	Bashahr	3	3240-3425 m
17.	Kalatop	1	2500 m
18.	Satrundi	1	3600 m
19.	Dalhousie	2	3000 m
20.	Danchho	2	3200 m
21.	Kulu	4	2400-3450 m
22.	Ghangaria	5	3000 m
23.	Jamunotri	4	2800-3200 m
24.	Panwali	4	3500-4000 m
25.	Kedarkanta	2	2700-3300 m
26.	Jaunsar	7	2700-3000 m
27.	Kumaon	4	3000-3500 m
28.	Changu	3	3600-3900 m
29.	Tchi-gook	1	4200 m
30.	NEFA, Sela Zang	1	3930 m

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