

PALMAR DERMATOGLYPHICS IN THREE NOMADIC
MENDELIAN ISOLATES

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The paper reports palmar dermatoglyphics of males and females of the three Mendelian isolates—Patils, Chougules and Komtis—of the nomadic Nandiwallas of Maharashtra, India. The analysis includes both qualitative and quantitative characters. Significant bilateral, bisexual and inter-group differences for several characters have been observed. The results have been discussed in the light of small numerical strength of the groups studied. Inter-group differences have been viewed in terms of the origin of these groups. The vast range of variation observed in several palmar features among these groups can best be explained as a result of genetic drift and/or founder effect.

INTRODUCTION

In 1969, the late Dr. Irawati Karve, in collaboration with the Indian Statistical Institute, Calcutta, initiated a multidisciplinary biosocial project among the non-pastoral nomadic Nandiwallas of Maharashtra. The aims and objective of the project, and relevant ethnographic details have been reported elsewhere (Malhotra 1974a; Malhotra and Khomne 1978; Malhotra *et al.* 1978). The biologic data pertaining to these groups, analysed so far, revealed marked differences from the other neighbouring populations (Malhotra 1974b; Malhotra *et al.* 1974a, b; Mutalik *et al.* 1974). Malhotra (1978) summarized these results and suggested that the observed unusual frequencies with respect to various biologic characters were due largely to genetic drift.

The aim of this paper is, therefore, besides reporting for the first time data on palmar dermatoglyphics among the three endogamous Nandiwalla groups (Patils, Chougules and Komtis), to examine if these groups show significant departures also in palmar features when compared to the Indian populations in general and neighbouring western Indian social groups in particular.

The Tirumal Nandiwallas, numbering around 2,500 (census taken in 1972), are true nomads whose traditional occupation is to go round in a set of hereditary villages with their sacred bullock (*nandi*), the vehicle of Lord Shiva, and collect rewards in cash and kind from the spectators who regard *nandi* as venerable object of worship. The Nandiwallas comprise of four rigid endogamous groups—Patils, Chougules, Komtis and Daundiwallas. The approximate numerical strength of these groups are 800, 1,150, 460 and 55 persons, respectively. Each of the four groups has a distinct social and ritual hierarchy.

MATERIAL AND METHODS

Bilateral palm prints of 378 Nandiwallas were collected in 1972, 1975, and 1979. The distribution of the sample groupwise and sexwise is indicated in Table 1. The prints have been analysed

TABLE 1. Distribution of the sample.

<i>Endogamous group</i>	<i>Sex</i>	<i>Sample size</i>	<i>Population size (1972)</i>
Patil	Male	96	800
	Female	75	
	Total	171	
Chougule	Male	50	1,150
	Female	49	
	Total	99	
Komti	Male	63	460
	Female	45	
	Total	108	
TOTAL	Male	209	2,410
	Female	169	
	Total	378	

after the methods of Cummins and Midlo (1961). Maximal atd angle and total number of triradii on palm were determined after Penrose (1949, 1954). Inter-digital ridge-counts were obtained following Holt (1949). The 17 palmar variables analysed in this paper are: main line D, C, B and A endings, position of axial triradii, total number of triradii, maximal atd angle, incidence of inter-digital accessory triradii, inter-digital ridge counts, patterns in configurational areas and ridge-dissociations.

RESULTS

Palmar main line terminations

The percent frequency distribution of the mainline D, C, B and A terminations are given separately for each group in Tables 2-5. A great deal of variation is noticed in the terminations of mainlines among the three groups. In decreasing order of magnitude the terminations of line D among the males are: Patils (11>10>9>7), Chougule (7>11>9>10), Komtis (11>7>9>10), while the females depict the order as Patils (11>9>10>8), Chougules (9>7>11>10), and Komti (7>9>11>10). The percent range of variation of the incidence of line D terminating at position 11 among the males and females is 29.0 (Chougules) to 66.49 (Patils) and 24.44 (Komtis) to 62.84 (Patils), respectively. Similarly, percent terminations at position 7 range from 7.33 (Patils) to 30 (Chougules) and 2.70 (Patils) to 31.11 (Komtis) among the males and females, respectively.

Significant inter-group variations are also observed with respect to the terminations of line C. Although in both the sexes of all the groups the line C terminates preponderantly at position 9, its range of variation is markedly high: among males 44% (Chougules) to 59.79% (Patils) and among females 35.55% (Komtis) to 61.49% (Patils). Terminations at position 5, likewise among both the sexes depict a wide range of variation; among males it varies from 7.4% (Patils) to 29% (Chougules), and among females it ranges from 3.38% (Patils) to 31.11% (Komtis).

Marked inter-group variations are also observed in the line B terminations. The percent incidence at position 5 (includes 5' and 5'') among the males and females varies from 20.74 (Patils) to 58.0 (Chougules) and 26.45 (Patils) to 62.22 (Chougules),

TABLE 2. Percent frequency of terminations of palmar main line D.

Endogenous group	Sex	Side	N	O	7	8	9	10	11	12	13
Patil	M	R	96	0.00	5.21	3.12	3.12	10.42	76.04	1.04	1.04
		L	95	0.00	9.47	1.05	17.89	14.74	56.84	0.00	0.00
		R&L	191	0.00	7.33	2.09	10.47	12.56	66.49	0.52	0.52
	F	R	74	0.00	1.35	2.70	9.46	10.81	75.68	0.00	0.00
		L	74	0.00	4.05	6.76	24.32	14.87	50.00	0.00	0.00
		R&L	148	0.00	2.70	4.73	16.89	12.84	62.84	0.00	0.00
Chougule	M	R	50	0.00	24.00	8.00	12.00	14.00	40.00	2.00	0.00
		L	50	0.00	36.00	6.00	28.00	12.00	18.00	0.00	0.00
		R&L	100	0.00	30.00	7.00	20.00	13.00	29.00	1.00	0.00
	F	R	49	0.00	26.53	0.00	22.45	10.20	40.82	0.00	0.00
		L	49	0.00	30.61	4.08	38.77	16.33	10.20	0.00	0.00
		R&L	98	0.00	28.57	2.04	30.61	13.26	23.51	0.00	0.00
Komti	M	R	62	0.00	24.19	3.23	16.13	6.45	50.00	0.00	0.00
		L	62	0.00	23.81	0.00	32.26	11.29	30.64	0.00	0.00
	F	R	124	0.00	25.00	1.61	24.19	8.87	40.32	0.00	0.00
		L	45	0.00	28.89	8.89	13.33	15.55	33.33	0.00	0.00
R&L	L	45	2.22	33.33	0.00	35.56	13.33	15.56	0.00	0.00	
	R&L	90	1.11	31.11	4.45	24.45	14.45	24.44	0.00	0.00	

TABLE 3. Percent frequencies of terminations of palmar main line C.

Group	Sex	Side	N	Positions										
				X	0	5	6	7	9	10	11			
Patil	M	R	94	0.00	1.06	4.26	5.32	3.19	7.45	69.15	7.45	2.13		
	L	95	1.05	6.32	5.26	9.47	1.05	23.16	50.53	2.11	1.05			
	R&L	189	0.53	3.70	4.76	7.40	2.12	15.34	59.79	4.76	1.59			
F	R	74	1.35	4.05	1.35	1.35	4.05	6.76	77.03	2.70	1.35			
	L	74	1.35	6.76	17.57	5.40	5.04	17.57	45.95	0.00	0.00			
	R&L	148	1.35	5.40	9.46	3.38	4.73	12.16	61.49	1.35	0.67			
Chougule	M	R	50	0.00	2.00	4.00	22.00	8.00	4.00	54.00	6.00	0.00		
	L	50	0.00	2.00	12.00	36.00	6.00	10.00	34.00	0.00	0.00			
	R&L	100	0.00	2.00	8.00	29.00	7.00	7.00	44.00	3.00	0.00			
F	R	49	0.00	2.04	4.08	26.53	0.00	14.28	46.94	4.08	2.04			
	L	49	0.00	6.12	6.12	30.61	4.08	16.33	36.73	0.00	0.00			
	R&L	98	0.00	4.08	5.10	28.57	2.04	15.30	41.84	2.04	1.02			
Komti	M	R	62	0.00	0.00	1.61	21.58	3.22	9.68	59.67	1.61	1.61		
	L	62	1.61	4.84	6.45	27.42	0.00	22.58	37.10	0.00	0.00			
	R&L	124	0.81	2.42	4.03	24.19	1.61	16.13	47.58	0.81	0.81			
F	R	45	0.00	4.44	8.89	28.89	11.11	4.44	40.00	2.22	0.00			
	L	45	0.00	8.89	15.55	33.33	0.00	11.11	31.11	0.00	0.00			
	R&L	90	0.00	6.67	12.22	31.11	5.55	7.77	35.55	1.11	0.00			

TABLE 4. Percent frequencies of terminations of palmar main line B.

<i>Endogenous</i> <i>group</i>	<i>Sex</i>	<i>Side</i>	<i>Positions</i>								
			<i>N</i>	3	4	5	6	7	8	9	
Patil	M	R	94	0	0	12.76	10.64	65.96	7.45	3.19	
		L	95	0	0	23.47	12.63	55.79	3.16	0	
	F	R&L	189	0	0	20.74	11.70	60.64	5.32	1.59	
		R	73	0	0	13.70	10.96	69.86	4.11	1.37	
Chougule	M	L	74	0	0	39.19	10.81	50.00	0	0	
		R&L	147	0	0	26.45	10.88	59.93	2.06	0.68	
	F	R	50	0	0	46.00	12.00	36.00	6.00	0	
		L	50	0	0	70.00	12.00	9.00	0	0	
Kontū	M	R&L	100	0	0	56.00	12.00	27.00	3.00	0	
		R	49	0	0	48.98	8.16	34.69	6.12	2.04	
	F	L	49	4.08	0	75.51	10.20	10.20	0	0	
		R&L	98	2.04	0	62.24	9.18	22.45	3.06	1.02	
Kontū	M	R	62	1.61	0	43.55	6.45	45.16	1.61	1.61	
		L	62	0	1.61	61.29	8.06	29.03	0	0	
	F	R&L	124	0.82	0.82	52.46	7.38	36.88	0.82	0.82	
		R	45	0	0	51.11	6.89	35.55	2.22	2.22	
Kontū	L	45	0	0	73.33	11.11	15.55	0	0		
	R&L	90	0	0	62.22	10.00	25.55	1.11	1.11		

TABLE 5. Percent frequencies of terminations of palmar main line A.

Endogamous group	Sex	Side	N	Line A Endings						
				1	2	3	4	5	6	7
Padii	M	R	96	0	0	19.79	15.63	62.50	0	2.08
		L	95	0	0	30.3	7.37	62.11	0	0
		R&L	191	0	0	25.16	11.50	62.30	0	1.04
	F	R	74	0	0	10.81	6.76	82.43	0	0
		L	74	0	0	28.38	9.46	62.16	0	0
		R&L	148	0	0	19.59	8.11	72.30	0	0
Chougule	M	R	50	0	0	30.00	8.00	60.00	2.00	0
		L	50	0	0	58.00	6.00	36.00	0	0
		R&L	100	0	0	44.00	7.00	48.00	1.00	0
	F	R	49	2.04	0	40.82	6.12	51.02	0	0
		L	49	6.12	2.04	44.90	6.12	40.82	0	0
		R&L	98	4.08	1.02	42.86	6.12	45.92	0	0
Komti	M	R	62	0	0	62.90	9.68	27.42	0	0
		L	62	0	0	72.58	9.68	17.74	0	0
		R&L	124	0	0	67.74	9.68	22.58	0	0
	F	R	45	0	0	57.78	6.67	35.55	0	0
		L	45	0	0	86.67	4.44	8.89	0	0
		R&L	90	0	0	72.23	5.55	22.22	0	0

respectively. The percent terminations at position 7 vary from 27 (Chougules) to 60.64 (Patils) among the males while the females reveal a range of 22.45 (Chougules) to 59.93 (Patils).

The terminations of line A also depicts wide variations among the groups. The percent terminations at position 5 among the males and females vary from 22.58 (Komtis) to 62.30 (Patils) and 22.22 (Komtis) to 72.30 (Patils), respectively. Terminations at position 3 likewise show a wide range of variation : among males and females the range being 25.16% (Patils) to 67.74% (Komtis) and 19.59% (Patils) to 72.23% (Komtis), respectively.

Axial triradii and maximal angle atd

The frequencies of axial triradii at different levels and in various combinations, in the three groups, are given in Table 6. In a large majority of palms there is but one axial triradius, most commonly situated at or very near the proximal border (t); among the males and females the range being 67.19% (Patils) to 83.09% (Komtis) and 64.42% (Patils) to 86.36% (Komtis), respectively. In terms of total number of types (levels and number of triradii in a single palm) the Patil males show maximum number (7) while Komti females reveal minimum (3). It is noteworthy that in all the three groups males record higher number of types compared to females. Bilateral differences in both the sexes of the three groups are not marked.

In terms of incidence of accessory axial triradii, the range among the males varies from 9% (Chougules) to 16% (Patils); while in females it ranges from 2.27% (Komtis) to 13% (Patils); males of all the three groups record higher number of accessory triradii compared to the females.

Table 7 presents data on maximal atd angle among these groups. The bilateral, the bisexual nor the inter-group differences among these groups were statistically significant (Tables 15-17).

Mean total number of palmar triradii

Data pertaining to this trait are presented in Table 8. The mean number of triradii among the males and females varies from 11.29 ± 1.61 (Komtis) to 11.78 ± 1.78 (Patils) and 10.82 ± 1.34 (Komtis) to 11.77 ± 1.49 (Chougules), respectively. The bilateral, the bisexual nor the inter-group differences among the three groups were statistically significant (Tables 15-17).

TABLE 6. Percent frequencies of types and combinations of axial triradii.

Endogamous group	Sex	Side	N	Positions of axial triradius													
				t	t'	t''	tt	tt'	tt''	tt't'	tt't''	tt't't'	tt't't''				
Patil	M	R	96	66.67	12.50	1.04	1.04	1.04	17.71	0	0	0	0	0	0	0	0
	L	96	67.71	17.71	0	1.04	0	12.50	0	0	0	0	0	0	0	0	1.04
	R&L	192	67.19	15.10	0.52	1.04	0.52	15.11	0	0	0	0	0	0	0	0	0.52
	F	R	69	66.67	14.49	0	0	14.49	2.90	0	1.45	0	0	0	0	0	0
	L	74	62.16	28.38	0	0	0	6.76	2.70	0	0	0	0	0	0	0	0
Chougule	R&L	143	64.42	21.44	0	0	0	10.62	2.80	0	0.72	0	0	0	0	0	0
	M	R	49	81.63	12.24	2.04	0	0	4.08	0	0	0	0	0	0	0	0
	L	50	72.00	14.00	0	0	4.00	6.00	0	0	0	0	0	0	0	2.00	2.00
	R&L	99	76.82	13.12	1.02	0	2.00	5.04	0	0	0	0	0	0	0	1.00	1.00
	F	R	48	81.25	12.50	0	0	0	6.25	0	0	0	0	0	0	0	0
Kontli	L	49	65.31	32.65	0	0	0	0	0	0	0	0	0	0	0	0	2.04
	R&L	97	73.28	22.57	0	0	0	3.13	0	0	0	0	0	0	0	0	1.02
	M	R	61	85.24	6.56	0	0	0	6.56	0	1.64	0	0	0	0	0	0
	L	63	80.95	9.52	0	0	0	7.94	0	0	1.59	0	0	0	0	0	0
	R&L	124	83.09	8.01	0	0	0	7.25	0	0.82	0.80	0	0	0	0	0	0
F	R	43	86.05	11.63	0	0	0	2.32	0	0	4	0	0	0	0	0	0
	L	45	86.67	11.11	0	0	0	2.22	0	0	0	0	0	0	0	0	0
	R&L	88	86.36	11.36	0	0	0	2.27	0	0	0	0	0	0	0	0	0

TABLE 7. Mean values of acid angle.

Endogamous group	Maximal and angle									
	Right hand		Left hand		Right and left					
	n	mean	S.D	n	mean	S.D	n	mean	S.D	
Patil	M	96	40.38	5.30	94	40.23	5.20	94	80.48	9.57
	F	68	40.91	5.34	73	41.49	4.97	68	82.56	9.15
Chougule	M	49	41.37	5.14	50	41.40	4.87	49	82.79	9.67
	F	48	41.17	4.60	49	41.88	4.46	48	83.19	8.33
Komti	M	61	41.15	5.25	62	41.79	4.57	61	82.98	9.28
	F	43	41.30	4.70	45	41.07	5.25	43	82.79	9.09

TABLE 8. Mean values of total number of palmar triradii.

Endogamous group	Number of triradii									
	Right hand		Left hand		Right and left					
	n	mean	S.D	n	mean	S.D	n	mean	S.D	
Patil	M	95	5.83	0.96	94	5.96	1.01	94	11.78	1.78
	F	73	5.68	0.93	74	5.68	0.89	73	11.36	1.64
Chougule	M	50	5.18	0.85	50	5.96	1.07	50	11.82	1.64
	F	49	5.92	0.81	49	5.85	0.89	49	11.77	1.19
Komti	M	62	5.55	0.76	62	5.77	0.99	61	11.29	1.61
	F	45	5.42	0.75	45	5.40	0.86	45	10.87	1.34

Palmar patterns

The percent incidence of patterns in palmar configurational areas are shown in Table 9. The order of magnitude of occurrence of true patterns, except among the Patils where it is III>IV>Hyp>II>Th/I, in both the sexes, is IV>III>Hyp>II>Th/I. The bimanual as well as the bisexual differences in the majority of the pattern areas are insignificant (Tables 15 and 16). Inter group comparisons revealed significant differences in the following pattern areas (Table 17): IIIrd (Chougule males differ from Patil and Komti males; Patil females differ from both Chougule and Komti females); IInd (Patil females differ from Komti females); and Hypothenar (Patil females differ from Komti females),

Accessory triradii d, c, b and a

The percent frequencies of accessory triradii occurring along with palmar triradii d, c, b, and a are given in Table 10. The order of magnitude of occurrence of accessory triradii in both the sexes of the three groups is d>a>c>b (the only exception being Komti females where c triradii records the minimum). The percent range of variation of accessory triradii d and a among the males is 37.5 (Patils) to 30.95 (Komtis) and 3.97 (Komtis) to 22.40 (Patils), respectively; the corresponding variation among the females are 24.45 (Komtis) to 43.88 (Chougules) and 1.11 (Komtis) to 17.35 (Chougules), respectively. It is noteworthy that in both the sexes of all the groups the accessory triradius at d always shows higher incidence on the left palm, while opposite is the case with triradius a. Bimanual differences, however, were statistically only significant in the females of Patils for triradius d (Table 15). Sex differences were insignificant in all the groups (Table 16). Both sexes of Komtis differ significantly from Patils and Chougules in the incidence of accessory triradius a; significant differences were also observed between females of Chougules and Komtis with respect to triradius d.

Palmar inter-digital ridge counts

The mean values and standard deviation of palmar inter-digital ridge counts—a-b, b-c and c-d—are presented in Tables 11, 12 and 13, respectively. Among both the sexes of three groups while the right palm records higher mean values for c-d

TABLE 9. Percent distribution of palmar patterns.

Endogamous group	Sex	Percent incidence of palmar patterns																
		Hypothenar			Thenar I			II			III			IV				
		P	A	n	P	CP	A	n	P	A	n	P	A	n	P	A	n	
Parsi	M	R	96	31.25	68.75	96	1.04	14.58	84.37	95	22.10	77.90	95	71.58	28.42	95	36.84	63.16
	L	R	96	21.87	78.12	96	5.21	26.04	68.75	96	20.83	79.17	96	45.83	54.17	96	60.42	39.58
	R&L	192	26.56	73.44	192	3.12	20.31	76.57	191	21.46	78.54	191	58.71	41.29	191	48.63	51.37	
	F	R	74	31.94	68.92	74	2.70	9.46	87.94	72	17.56	81.94	72	77.78	22.22	72	30.55	69.45
Chougule	L	R	74	20.27	79.73	74	0	24.32	75.67	74	16.22	83.78	74	59.19	40.81	74	58.10	41.89
	R&L	148	26.10	73.89	148	1.35	16.89	81.76	146	17.12	82.88	146	58.48	41.52	146	44.32	55.68	
	M	R	50	34.00	66.00	50	2.00	14.00	84.00	50	18.00	82.00	50	56.00	44.00	50	66.00	34.00
	L	R	50	32.00	68.00	50	0	18.00	82.00	50	10.00	90.00	50	32.00	68.00	50	78.00	22.00
Komi	R&L	100	33.00	67.00	100	1.00	16.00	83.00	100	14.00	86.00	100	44.00	56.00	100	72.00	28.00	
	F	R	49	24.49	75.51	49	0	22.45	77.55	49	16.33	83.67	49	59.18	40.82	49	73.47	26.53
	L	R	49	24.49	75.51	49	10.20	12.24	77.55	49	2.04	97.96	49	14.28	85.71	49	40.32	59.18
	R&L	98	24.49	75.51	98	5.10	17.35	77.55	98	9.18	90.82	98	96.73	3.27	98	57.15	42.85	
Komi	M	R	62	17.74	82.26	62	0	12.90	87.10	62	4.84	95.16	62	64.52	35.48	62	51.61	48.39
	L	R	62	20.97	79.03	62	4.84	16.13	79.03	62	4.84	95.16	62	33.87	66.13	62	72.53	27.42
	R&L	124	19.36	80.64	124	2.42	14.52	83.06	124	4.84	95.16	124	49.20	50.80	124	62.09	37.91	
	F	R	45	13.33	86.67	45	0	22.22	77.78	45	2.22	97.78	45	46.67	53.33	45	64.44	35.55
Komi	L	R	45	15.55	84.44	45	2.22	20.00	77.78	45	0	100.00	45	31.11	68.89	45	64.44	35.55
	R&L	90	14.44	85.56	90	1.11	21.11	77.78	90	1.11	98.89	90	38.89	61.11	90	64.44	35.55	

TABLE 10. Percent distribution of accessory triradii.

Endogamous group	Percent incidence of accessory triradii												
	Right				Left				Right and left				
	N	d	c	b	a	d	c	b	a	d	c	b	a
Patil	M	96	31.25	0	23.96	43.75	1.04	0	20.83	37.5	0.52	0	22.40
	F	74	25.67	1.35	0	17.57	44.59	1.35	0	14.86	35.13	1.35	0
Chougule	M	50	28.00	2.00	0	20.00	38.00	2.00	0	12.00	33.00	2.00	0
	F	49	36.73	2.04	4.08	20.40	51.02	4.08	0	14.28	43.88	3.03	2.04
Komti	M	63	22.22	4.76	1.59	4.76	39.68	1.59	0	3.17	30.95	3.17	0.79
	F	45	15.55	0	2.22	2.22	33.33	0	0	24.45	0	1.11	1.11

TABLE 11. Mean and standard deviation of the palmar a-b ridge counts.

Endogamous group	a-b ridge count									
	Right hand			Left hand						
	n	mean	S. D.	n	mean	S. D.				
Patil	M	92	33.79	4.82	94	35.19	5.22	91	68.97	9.96
	F	71	31.48	4.31	72	32.49	4.08	71	63.94	7.30
Chougule	M	49	32.59	5.26	50	35.64	4.79	49	66.20	9.13
	F	49	32.57	5.22	49	34.18	5.21	49	66.73	9.53
Komti	M	62	35.18	4.38	61	37.08	4.49	61	72.15	8.12
	F	45	33.78	5.12	43	36.23	5.60	43	70.05	9.82

TABLE 12. Mean and standard deviation of palmar b-c ridge counts.

Endogenous group	b-c ridge count											
	Right hand				Left hand				Right and left			
	n	mean	S. D.	n	mean	S. D.	n	mean	S. D.	n	mean	S. D.
Patil	M	88	20.73	5.20	89	20.68	4.92	84	41.81	9.46		
	F	70	19.49	5.64	59	21.13	4.96	59	41.51	9.55		
Chougule	M	47	24.19	5.29	44	25.68	4.97	42	50.45	9.70		
	F	46	23.46	4.99	46	24.11	4.92	44	47.48	8.56		
Komti	M	61	24.93	5.82	57	25.61	5.33	56	51.11	9.61		
	F	41	26.15	5.79	35	29.03	5.11	35	56.26	9.79		

TABLE 13. Mean and standard deviation of palmar c-d ridge counts.

Endogenous group	c-d ridge counts											
	Right hand				Left hand				Right and left			
	n	mean	S. D.	n	mean	S. D.	n	mean	S. D.	n	mean	S. D.
Patil	M	88	33.18	4.80	89	32.03	5.35	84	65.51	8.90		
	F	70	31.50	5.19	59	30.20	4.96	59	62.05	9.60		
Chougule	M	48	31.56	4.88	44	29.77	4.61	43	61.28	8.21		
	F	46	30.54	5.27	46	29.30	7.51	44	60.07	11.84		
Komti	M	60	32.17	5.94	57	31.98	5.77	55	64.27	9.90		
	F	41	32.27	5.90	35	32.60	7.14	35	63.29	11.59		

counts, in the case of a-b and b-c counts it is the left palm which has higher counts. Bilateral differences, however, are significant only among the Chougule males and Komti females for a-b and b-c ridge counts, respectively. Bisexual significant differences are found among the Patils for a-b and c-d ridge counts, and among Komtis for b-c ridge counts (Table 16). Statistically significant differences were observed between the pairs: Patil and Chougule males for b-c and c-d ridge counts; Patil and Chougule females for b-c counts; both sexes of Patils and Komtis for a-b and b-c ridge counts; Chougule and Komti males for a-b count and Chougule and Komti females for b-c and c-d counts (Table 17).

Ridge-dissociation

Data on this feature are presented in Table 14. Although the incidence of this trait appears to be consistently higher on the left palms compared to the right palms, the bilateral differences in none of the groups reach significant levels (Table 15). Of the three groups only Komtis reveal significant bisexual differences (Table 16). Chougule males differ significantly from Patil and Komti males (Table 17).

DISCUSSION

The results of this study will now be viewed in terms of the small numerical strength of the Nandiwalla groups. It is well established that the magnitude of genetic drift on such numerically small endogamous groups will be profound and, therefore, among these groups, it is expected that (a) the biological profile of some traits may differ from the general reported trend, and (b) some of the palmar traits are likely to reveal 'unexpected' frequencies. It will also be of interest to examine the observed inter-group differences in terms of the origin of these groups. (a) The observation that the ridge direction of the main line terminations tends towards a more transverse alignment in the right hand (Cummins and Midlo, 1961:197) holds good in both the sexes of the three groups. The general observations that in right hand line A terminates more frequently in the distal levels of ulnar border, and line D tends to course further radialwards is also true in the present

TABLE 14. Percent distribution of ridge-dissociation.

Endogenous group	Sex	N	Ridge-dissociation (%)		
			Right	left	Right and left
Patil	M	96	13.54	12.50	13.02
	F	75	8.00	13.33	10.67
Chougale	M	50	2.00	4.00	3.00
	F	49	6.12	6.12	6.12
Komti	M	63	25.40	33.33	29.36
	F	45	8.88	13.33	11.11

TABLE 15. Results of t and chi-square tests for testing bilateral homogeneity.

Character	Patil		Chougale		Komti	
	Male	Female	Male	Female	Male	Female
(a) t-values for						
1. a-b ridge counts	1.90	1.44	3.01*	1.53	0.42	0.05
2. b-c "	0.06	1.76	1.38	0.63	0.66	2.31*
3. c-d "	1.51	1.45	1.81	0.92	0.22	0.25
4. and angle "	0.20	0.67	0.30	0.77	0.72	0.22
5. No. of triradii	0.91	0.00	0.41	0.35	1.38	0.12
(b) Chi-square values for						
6. Hypothenar	0.22	2.27	0.64	0.00	0.20	0.09
7. Thenar/I	2.75	0.53	0.01	3.55	1.43	0.00
8. II inter digital	0.05	0.09	1.33	5.99*	0.00	0.00
9. III interdigital	0.13	2.23	5.84*	2.12	1.16	2.29
10. IV interdigital	1.06	1.12	1.78	10.67*	5.79*	0.00
11. Accessory triradii at 'a'	0.27	0.20	1.19	0.64	0.21	0.00
12. " " " at 'd'	3.31	5.61*	1.13	1.46	3.67	3.31
13. Ridge dissociation	0.03	1.12	0.34	0.00	0.96	0.45

* Significant at 5% level and below.

TABLE 16. Results of t and chi-square tests for testing bisectal homogeneity.

Character	Pa'il	Chougule	Komti
(a) t-values			
1. a-b ridge count	3.84*	0.78	1.15
2. b-c ridge count	0.18	1.55	2.46*
3. c-d ridge count	2.25*	0.56	0.43
4. atd angle	1.40	0.22	0.11
5. No. of triradii	1.58	0.16	1.64
(b) Chi-square values			
6. Hypothenar	0.34	0.17	0.88
7. Thenar/I	1.14	2.83	0.49
8. IInd Interdigital	0.99	1.12	2.29
9. IIIrd Interdigital	0.06	0.11	2.24
10. IV Interdigital	0.58	0.48	1.23
11. Accessory triradii at 'a'	2.02	0.06	1.59
12. " " at 'd'	0.20	2.48	1.10
13. Ridge dissociation	0.44	1.11	10.27*

* Significant at 5% and below levels.

TABLE 17. Results of t and chi-square tests for testing inter-group homogeneity.

Group pair	t-values			Chi-square values					Necessary triadit				Ridge dis- cussion
	a-b	b-c	c-d	atd	angle	No. of triadit	Hy	Th/I	II	III	IV	a	
(a) Males													
1. Patil x Chougule	0.47	4.92*	2.73*	1.36	0.13	1.33	1.27	2.39	5.66*	0.33	1.67	0.57	7.62*
2. Patil x Komti	2.19*	5.64*	0.81	1.62	1.77	2.16	0.14	1.64	2.71	2.54	20.18*	1.43	1.29
3. Chougule x Komti	2.37*	0.34	1.63	0.10	1.71	0.17	0.64	0.57	6.00*	2.44	9.37*	0.11	26.60
(b) Females													
1. Patil x Chougule	1.73	3.33*	0.91	0.38	1.43	0.44	3.03	3.08	10.83*	3.74	0.05	1.90	1.51
2. Patil x Komti	3.53*	7.13*	1.39	0.13	1.95*	4.19*	0.03	14.56*	8.32*	0.88	13.58*	2.98	0.01
3. Chougule x Komti	1.64	4.18*	1.97*	0.22	3.25*	0.30	2.42	6.07*	0.09	1.03	16.11*	7.83*	1.50

* Significant at 5% and below levels.

series. The present findings that line C is more frequently abortive or absent in left hands is in agreement with previous results.

The general trend that palmar patterns on hypothenar, IInd and IIIrd interdigital areas are higher on the right palm while Thenar/I and IVth interdigital on left agrees with the present results. With respect to sexual variation hypothenar and IVth interdigital patterns occur more abundantly among the females while in males Thenar/I patterns and IInd and IIIrd interdigital patterns show higher frequencies. Contrary to this in the present series several departures are noticed (for details see Table 9).

It is generally observed that the female and angles tend to be greater and more variable (Holt, 1968 : 87). In the present series while the female angles are greater they are less variable compared to the males (see S. D. values in Table 7).

It has been suggested that in general bilateral differences are more pronounced among the males. In the present work, of the 13 traits where bilaterality has been tested (Table 15), males depicted significant differences in three traits while females in four traits.

The general trend that mean a-b ridge count on the left hand is higher than that on the right hand (in both sexes) has also been observed in the present series.

It is thus noteworthy that, while broadly speaking the traits considered in this paper do confirm to the trends already established, for some traits significant departures have also been observed.

(b) To examine whether the frequencies of various palmar traits observed in the Nandiwalla groups fall within the range of the reported frequencies among ethnically similar groups, the present findings have been compared with other groups; unfortunately for a number of traits considered in this paper comparable data are not readily available.

A comparison of percent frequency of terminations of main line D at positions 7, 9 and 11 among Nandiwalla groups and four samples of Indians (Plato *et al.* 1975) reveals that the Nandiwalla

groups show major departures from the observed range of variation [Indian percent range: 7 (18-23), 9 (23-34), 11 (48-56); Nandiwalla groups : 7 (2.7-31.1), 9 (10.5-30.6), 11 (24.4-66.5)]

Percent incidence of C line modal types (Plato 1970) among the Nandiwalla groups and other Indians (Plato *et al.* 1975) are given in Table 18. Striking departures are noticed in ulnar, radial and absent modal types.

Data on a-b ridge counts are available on 21 Caucasoid Indian populations with a range of 68.19-82.89 mean counts, average being 76.50. Except for one population the Nandiwalla groups record rather low mean values for a-b count; the Patil females possess the lowest mean count (63.94) reported so far.

The range of the percent frequencies of the palmar patterns among the Nandiwalla groups and 7 Asian Indians (after Plato *et al.* 1975) are given in table 19. All the five pattern areas, except patterns in hypothenar area, among the Nandiwallas show strong variations from the known range of distribution.

Inter-group variation

Of the 13 palmar traits that have been compared statistically, except for atd angle, patterns on Thenar/I interdigital and IVth interdigital areas, significant differences (5% and below levels) have been observed in all the traits for at least one pair of groups. The traits that showed maximum heterogeneity among these groups are b-c ridge count, patterns in IIIrd interdigital area and accessory triradii a.

The results of inter-group comparisons between the three Nandiwalla groups are summarized in Table 20. The Patils differ from Chougules and Komtis in 6 and 9 characters, respectively. The Chougules differ from the Komtis in 10 characters. It is interesting to observe that the females of these groups as compared to the males show relatively more heterogeneity; the females differ in 14 characters while males in 11. Of the 78 pair-wise comparisons between the three groups, 25 (32.05%) pairs showed statistically significant differences.

TABLE 18. Percent incidence of C line modal types among the 3 Nandiwalla groups compared with other Indian populations.

Line C modal types	Group								Range	
	Patil		Chougule		Komti		Indians*		Male	Female
	Male	Female	Male	Female	Male	Female	Male	Female		
Ulnar	24.9	20.3	43.0	45.9	41.9	44.4	32	37		
Radial	66.1	63.5	47.0	44.9	49.2	36.7	46	57		
Proximal	4.2	6.7	2.0	4.1	3.2	6.7	0	13		
Absent	4.8	9.5	8.0	5.1	4.0	12.2	6	8		

* Based on four populations (Plato *et al.*, 1975 : 209).

TABLE 19. The range of the percent frequencies of the palmar patterns among the Nandiwalla groups compared with Indian populations.

Palmar pattern areas	Three Nandiwalla groups	Indians*
Hypobhenar	14.4 — 33.0	15 — 35
Thenar/I	1 — 5.1	3 — 21
II	1 — 21.5	2 — 6
III	36.7 — 58.7	51 — 53
IV	44.3 — 72.0	49 — 61

* Based on seven population samples (Plato *et al.* 1975 : 209).

TABLE 20. Inter-group comparisons (13 characters considered).

Group pair	Number of traits in which they differ significantly	
	Male	Female
Patil x Chougule	4	2
Patil x Komti	3	6
Chougule x Komti	4	6
Total	11	14
		25

The departures observed above in the biological profile of some of the traits and in the incidence of the traits when compared to similar ethnic groups could best be explained by considering two equally competing hypothesis, namely (1) that the departures are due to differences in the ethnic background of the Nandiwalla groups, and (2) that the differences are attributable to the small numerical strength of the groups.

The anthropometric characters and scopic observations suggest beyond doubt that the Nandiwalla groups belong to the ethnic group referred to as Mediterranean or broadly speaking Caucasoid (Malhotra 1974a). The population groups with which the Nandiwalla groups have been compared are also Caucasoids. Therefore, it is most unlikely that the departures noted earlier are due to differences in the ethnic affiliation of the Nandiwalla group.

On the other hand the population sizes of these groups are very small, and as a matter of fact the effective population sizes, yet to be calculated, will work out much smaller. If 30% of the population is considered as the effective size, as reported by Salzano and Freire-Maia (1970), the values of this parameter works out 240 (Patil), 345 (Chougules) and 138 (Komtis).

Since it is well-known that genetic drift operates at its optimum in populations with small numerical strength, the 'unexpected' frequencies observed in several palmar traits can best be interpreted as a result of genetic drift. It may be mentioned here that earlier Malhotra (1974b); Malhotra *et al.* (1974a, b); and Mutalik *et al.* (1974), reported among the Nandiwalla groups absence of allele p^2 and Hp^0 , the lowest frequency of allele p^1 (0.02603) ever recorded among Indian populations, the lowest frequency of gene Hp^1 ever reported in human populations, an extremely high incidence of Rh (-) gene, loss of gene for attached ear lobes, absence of gene (s) for colourblindness and unusually low frequencies of whorls on the fingers. These results were considered in detail by Malhotra (1970) who concluded that the observed frequencies of various traits among the Nandiwallas can best be explained as a result of genetic drift.

Let us now examine the observed inter-group differences in the light of the origin of the Nandiwalla groups. Malhotra and

Khomne (1978) and Malhotra (1979) showed that the four Nandiwalla groups arose from originally one endogamous group through the process of excommunication. Originally, thus, there was one group now represented by the Patils. Some of the Patils in the distant past were excommunicated, who formed the second ranking group, the Chougules. Persons excommunicated from the Chougules formed the third ranking group the Komtis and the Daundiwallas who are at the bottom of the hierarchy were outcastes from the Komtis. The offences that led to excommunication were of four types, namely, (1) incestuous (2) marrying relatives of certain categories but non-incestuous (3) sex relations with non-Nandiwallas, and (4) marrying a non-Nandiwalla.

The above process through which the Nandiwalla groups have been formed would influence the genetic structure of these populations in two ways. Firstly, the admixture with other populations would increase heterogeneity and secondly the small founding members would lead to founder effect. The consequence of both these aspects would be to increase heterogeneity between those groups. The magnitude of inter-group differences observed with respect to palmar dermatoglyphic traits could thus be interpreted as the consequence of admixture at the time of group formation and the small number of founding members.

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