

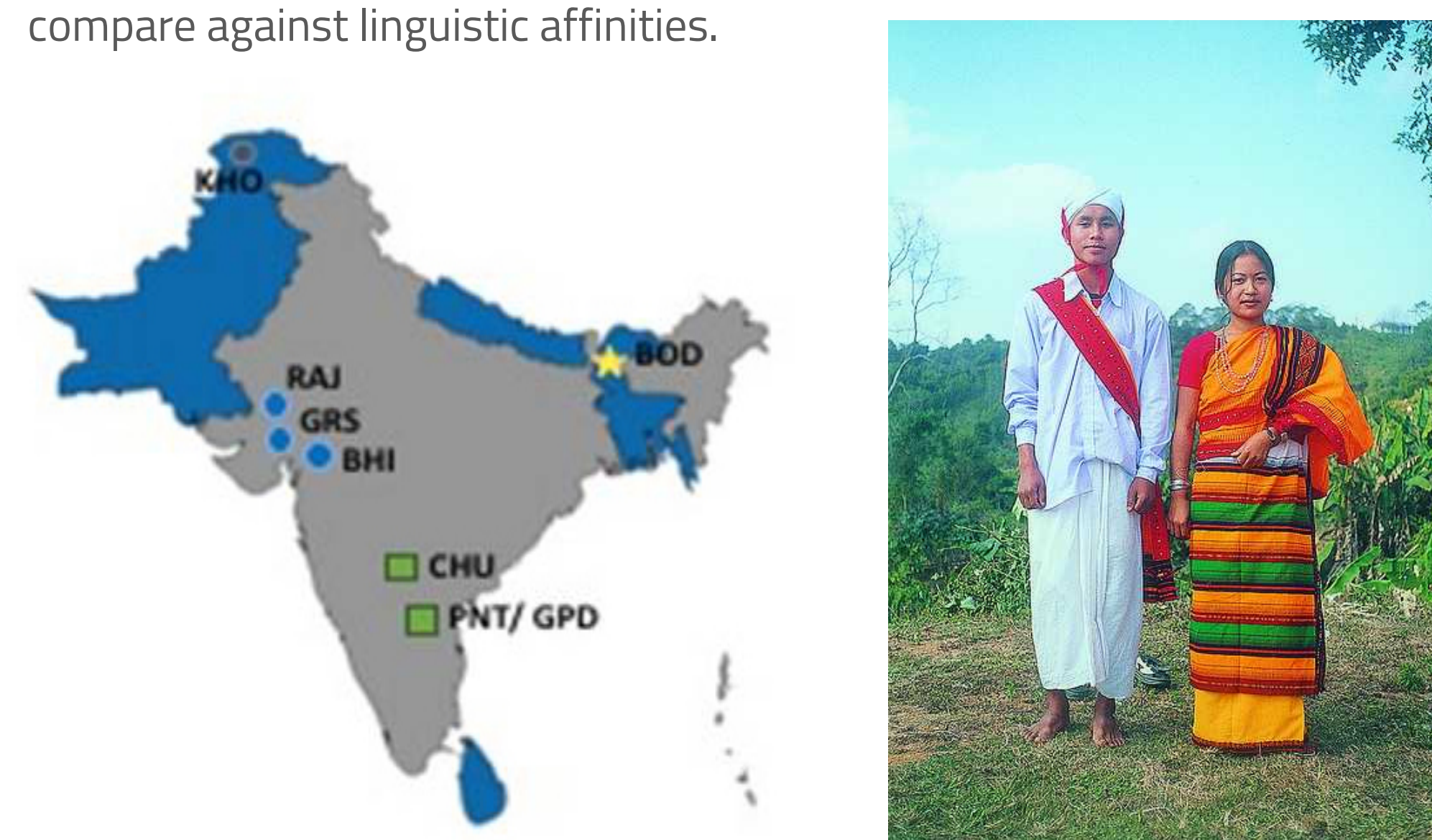
# A Tooth Size Apportionment Investigation into Bodo Origins

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## INTRODUCTION

The Bodo are an ethnic group located in the hill country north of the Brahmaputra River valley of Assam, on northeastern India. Linguistic affinities most closely resemble those found south of the Brahmaputra River Valley (Van Driem, 2014), however, their relatedness to other ethnic groups is currently unknown. Dental measurements can be used as a proxy for biological affinities (Harris, 1989; Hemphill, 2016) in an effort to test which regional groups the Bodo share closest affinities to and compare against linguistic affinities.



## MATERIALS

The materials for this project consist of diestone dental casts taken from post-secondary student volunteers between the ages of 14 and 20. M-Mesiodistal (MD) and buccolingual (BL) dimensions were measured for all teeth, except third molars. EM estimation was used to estimate the values of missing dimensions due to congenital absence, trauma, non-eruption or casting defects. Samples with more than 4 estimated values were removed from the data pool. Overall, data estimation encompassed only 3.7% of measurements among Bodos.

Samples

Group Name	Abbreviation	Region	Total Sample Size	Male Sample Size	Female Sample Size
★ Bodo	BODu		92	45	47
● Khohar	KHO	N. Pakistan	186	92	94
● Bhils	BHI	N.W. India	159	90	69
● Garasias	GRS	N.W. India	190	101	89
● Vaghela Rajputs	RAJ	N.W. India	154	127	27
■ Chenchus	CHU	S.E. India	171	103	68
■ Gompadhompti	GPD	S.E. India	138	68	70
■ Pakanati Reddis	PNT	S.E. India	153	93	60
▲ Hmars	HMR	N.E. India (Kuki)	143	73	70
▲ Koms	KOM	N.E. India (Kuki)	101	52	49
▲ Paites	PAI	N.E. India (Kuki)	131	69	62
▲ Sema Nagas	SEM	N.E. India (Naga)	184	81	103
▲ Tangkhul Nagas	TNK	N.E. India (Naga)	150	70	80
◆ Gurungs	GUR	N.E. India (North)	112	55	57
◆ Sherpas	SHO	N.E. India (North)	103	43	60

N. Pakistan: n= 186  
N.W. India: n= 503  
S.E. India: n= 462

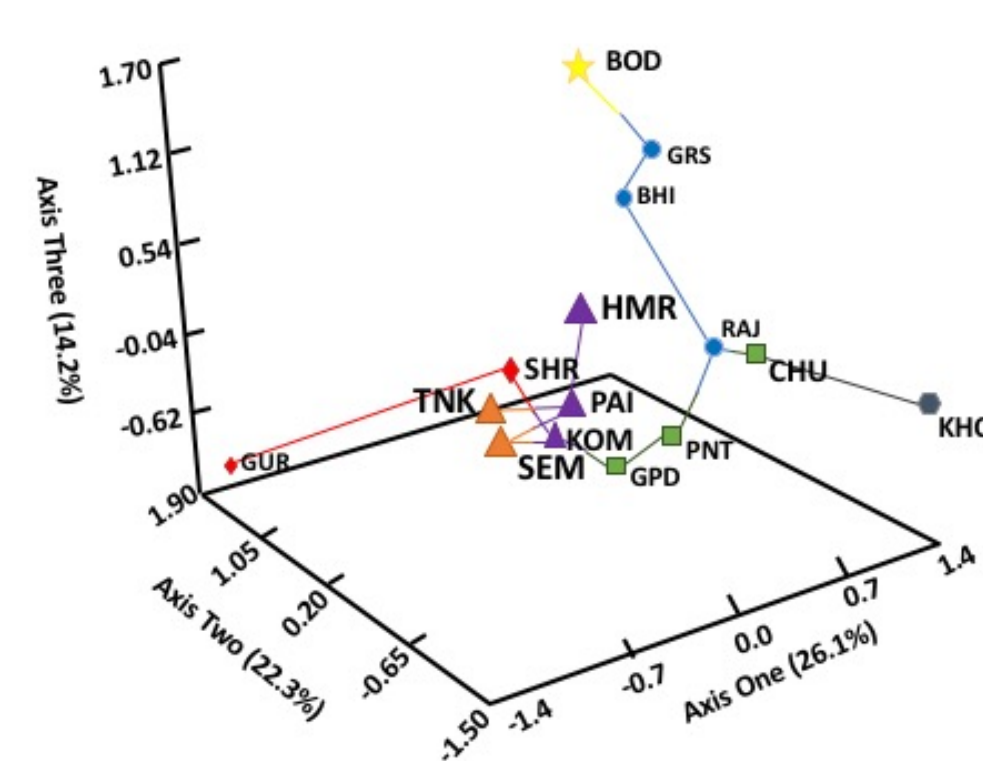
N.E. India (Kuki): n= 375  
N.E. India (Naga): n= 334  
N.E. India (North): n=215

## METHODOLOGY

- Samples were scaled against the geometric mean by individual to eliminate variability in gross size due to sex dimorphism and differential histories of agricultural production and ceramic technology. Samples were examined with Shapiro-Wilk and Levene tests to ensure conformity to normality and homogeneity of variance.
- Canonical variates analysis (CVA) of the geometrically scaled data, along with multidimensional scaling and neighbor-joining cluster analysis derived from the triangular matrix of pairwise posterior probability classifications were used to compare the Bodo to ethnic groups throughout the region and across the Indian Subcontinent.

## RESULTS

Canonical Variates Analysis (CVA)



Original CVA Classification Matrix based on all 28 Variables

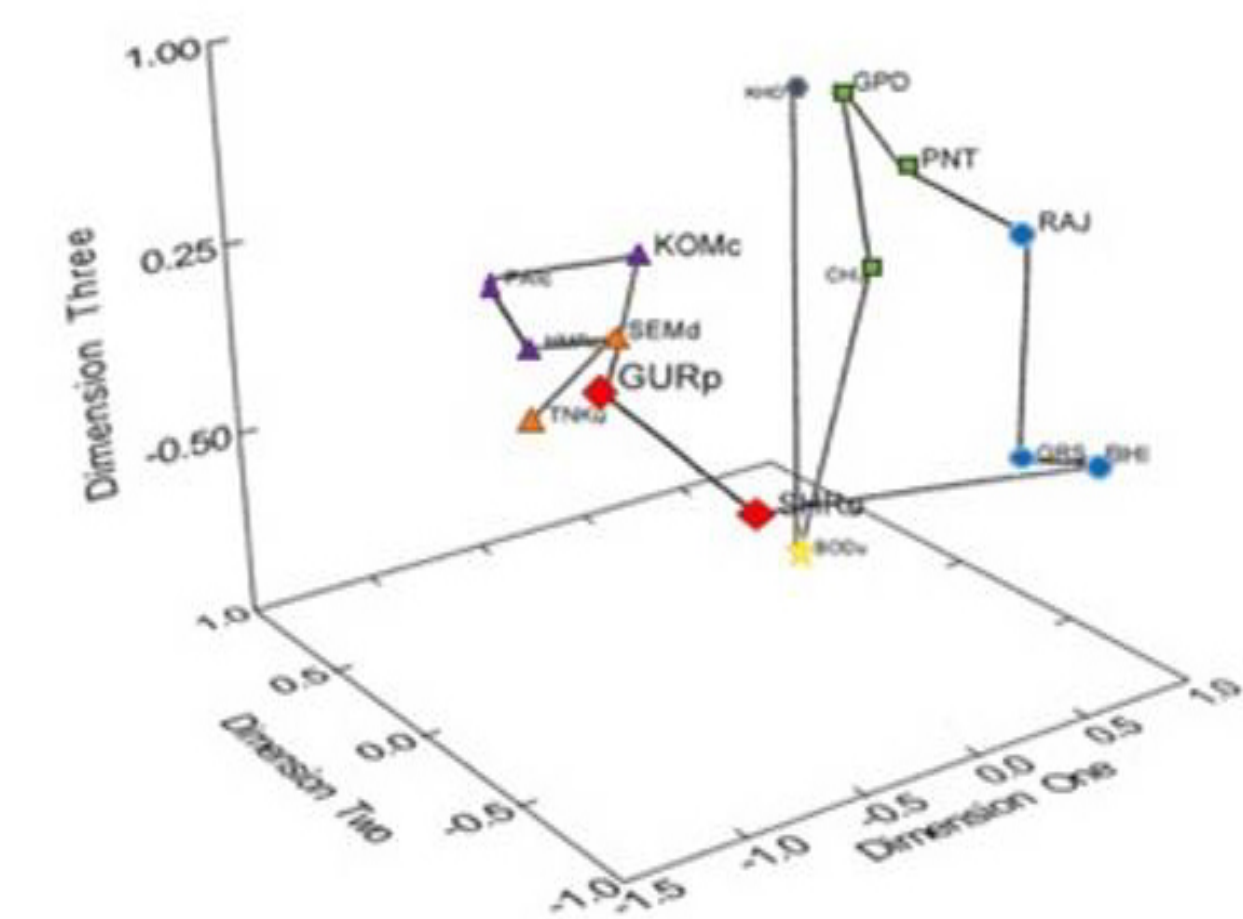
	BHI	BOD	CHU	GPD	GRS	GUR	HMR	KHO	KOM	PAI	PNT	RAJ	SEM	SHR	TNK	% correct
BHI	91	4	3	3	23	0	0	8	0	2	11	6	5	2	1	57
BOD	5	37	9	1	12	0	5	2	0	2	1	4	5	4	5	40
CHU	6	6	77	7	9	0	11	11	2	7	9	14	7	0	5	45
GPD	9	0	8	52	3	0	4	7	6	9	16	8	6	5	5	38
GRS	23	5	8	7	99	0	4	9	2	3	8	12	4	2	4	52
GUR	4	3	1	3	6	44	2	0	7	6	8	2	10	12	4	39
HMR	3	1	8	2	7	1	39	11	10	21	3	3	10	2	22	27
KHO	5	2	5	7	4	0	3	137	0	4	6	5	5	0	3	74
KOM	3	1	4	11	4	0	5	3	34	5	4	6	14	5	2	34
PAI	3	0	2	7	4	0	21	1	11	45	6	4	9	2	16	34
PNT	10	3	16	18	12	0	2	15	5	4	41	15	5	4	3	27
RAJ	5	1	17	9	22	0	0	15	9	3	10	56	5	1	1	36
SEM	10	4	5	9	0	0	8	5	5	7	8	9	91	4	19	49
SHR	10	4	3	9	5	0	6	3	5	0	3	4	21	22	8	21
TNK	4	4	7	3	2	0	9	8	7	10	2	6	18	2	68	45
Total	191	75	173	148	212	45	119	235	103	128	136	154	215	67	166	43

Jackknifed CVA Classification Matrix based on all 28 Variables

	BHI	BOD	CHU	GPD	GRS	GUR	HMR	KHO	KOM	PAI	PNT	RAJ	SEM	SHR	TNK	% correct
BHI	83	5	3	5	26	0	0	9	0	2	11	7	5	2	1	52
BOD	6	32	9	1	12	0	5	3	0	2	1	4	5	4	8	35
CHU	6	6	75	7	9	0	11	12	2	7	9	15	7	0	5	44
GPD	9	0	9	40	4	0	5	7	7	9	22	9	7	5	5	29
GRS	22	7	9	7	91	0	6	11	2	3	10	12	4	2	4	48
GUR	4	3	1	3	6	44	2	0	7	6	8	2	10	12	4	39
HMR	3	3	9	4	7	1	30	11	11	22	3	3	10	2	24	21
KHO	4	3	6	7	5	0	3	132	0	4	7	7	5	0	3	71
KOM	3	1	4	11	4	0	6	5	26	7	4	6	15	7	2	26
PAI	3	0	2	8	4	0	21	1	10	42	6	5	11	2	16	32
PNT	10	3	19	22	13	0	2	16	5	4	28	16	7	5	3	18
RAJ	5	1	19	9	22	0	0	15	10	3	11	51	6	1	1	33
SEM	11	4	6	9	0	0	8	5	6	8	8	9	81	5	24	44
SHR	10	5	4	10	6	0	6	3	6	0	3	4	22	16	8	16
TNK	4	4	8	3	2	0	11	9	7	12	2	6	21	3	58	39
Total	183	77	183	146	211	45	116	239	99	131	133	156	216	66	166	38

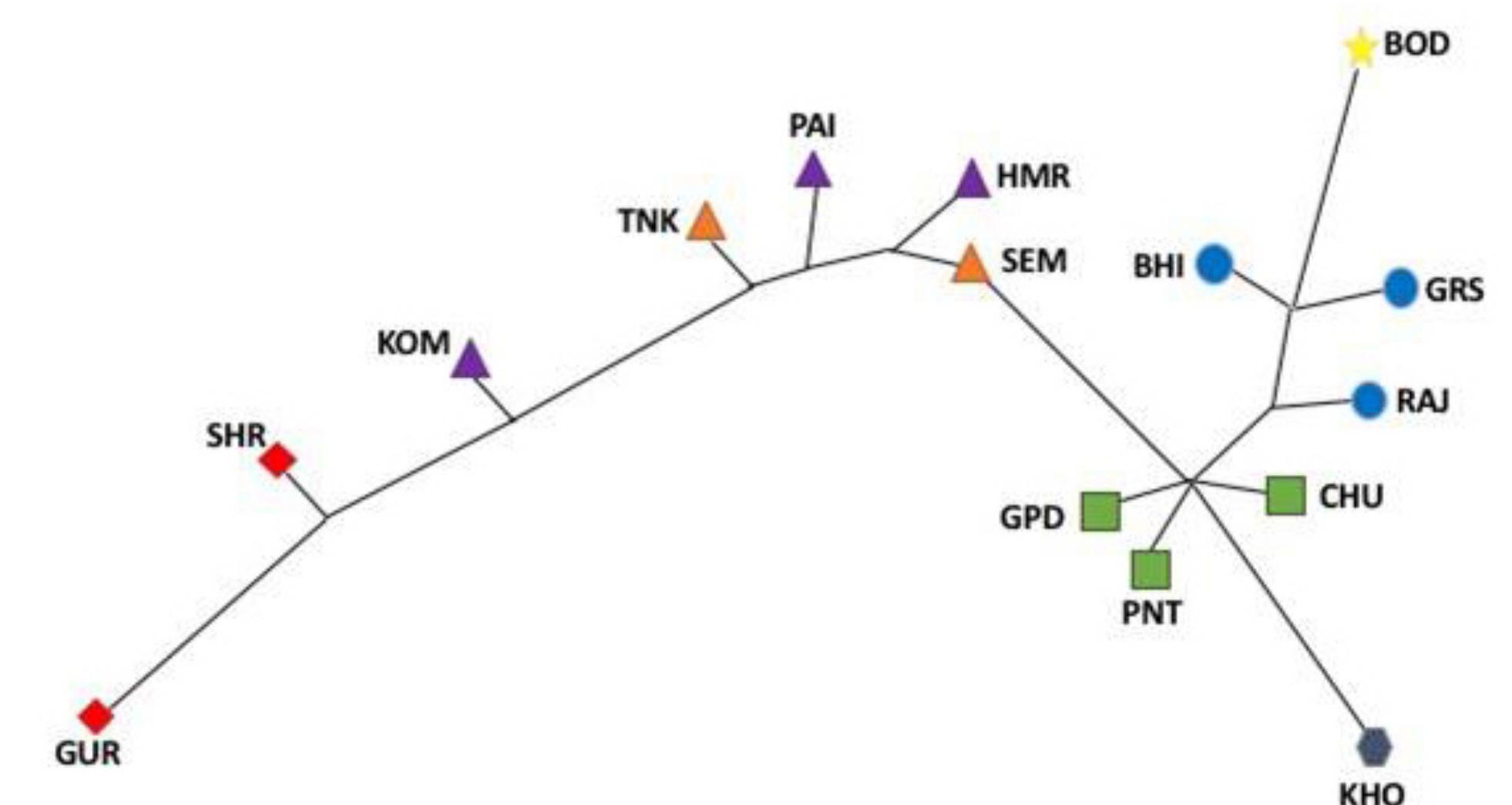
40% of Bodos correctly identified in the original matrix, 35% in the Jackknifed matrix. Overall, correct assignments by ethnic group 5x greater than by chance.

Multi-Dimensional Scaling Analysis



Multidimensional scaling was accomplished with a stress value of 0.152 after 10 iterations accounting for 82.8% of the variance. Bodos occupy an isolated position in the lower center. Peninsular Indians occupy the right side and are distinguished by region, while Naga/Kuki groups occupy the left.

Neighbor-Joining Cluster Analysis



- Bodos are an isolate with no affinities to the other groups considered.
- Naga and Kuki groups share closer affinities previously expected.
- Peninsular Indians are marked by regional structure.
- Khohar of northern Pakistan also isolated from other South Asians.

## DISCUSSION

- Bodos represent phenotypic isolates without affinities to groups south of the Brahmaputra Valley (Nagas, Kukis). This is concordant with assertions of Bodo linguistic affinities to languages spoken to the north on the Tibetan Plateau.
- Nagas & Kukis share unexpectedly close affinities to one another, but are clearly distinct from South Asians of other regions.
- Gurungs and Sherpas are also distinguished from other ethnic groups of northeastern India, probably reflecting their Nepali origins.

## ACKNOWLEDGEMENTS

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