

28 April 1981

N. V. Joshi
Indian Institute of Science
Bangalore, India

Dear Joshi:

I hope this letter finds you well and in good spirits.

As Ragavendra may have mentioned to you, I have a problem in statistics on which I would like to consult ~~with~~ you. (I know of course that the idea of having a workshop in Mahableshwar was not to put western scientists in contact with clever Indians whose talents they could subsequently make use of, but I can also see the benefits, illustrated graphically in your collaborations with Ragavendra, of knowing a "tame" statistician!)

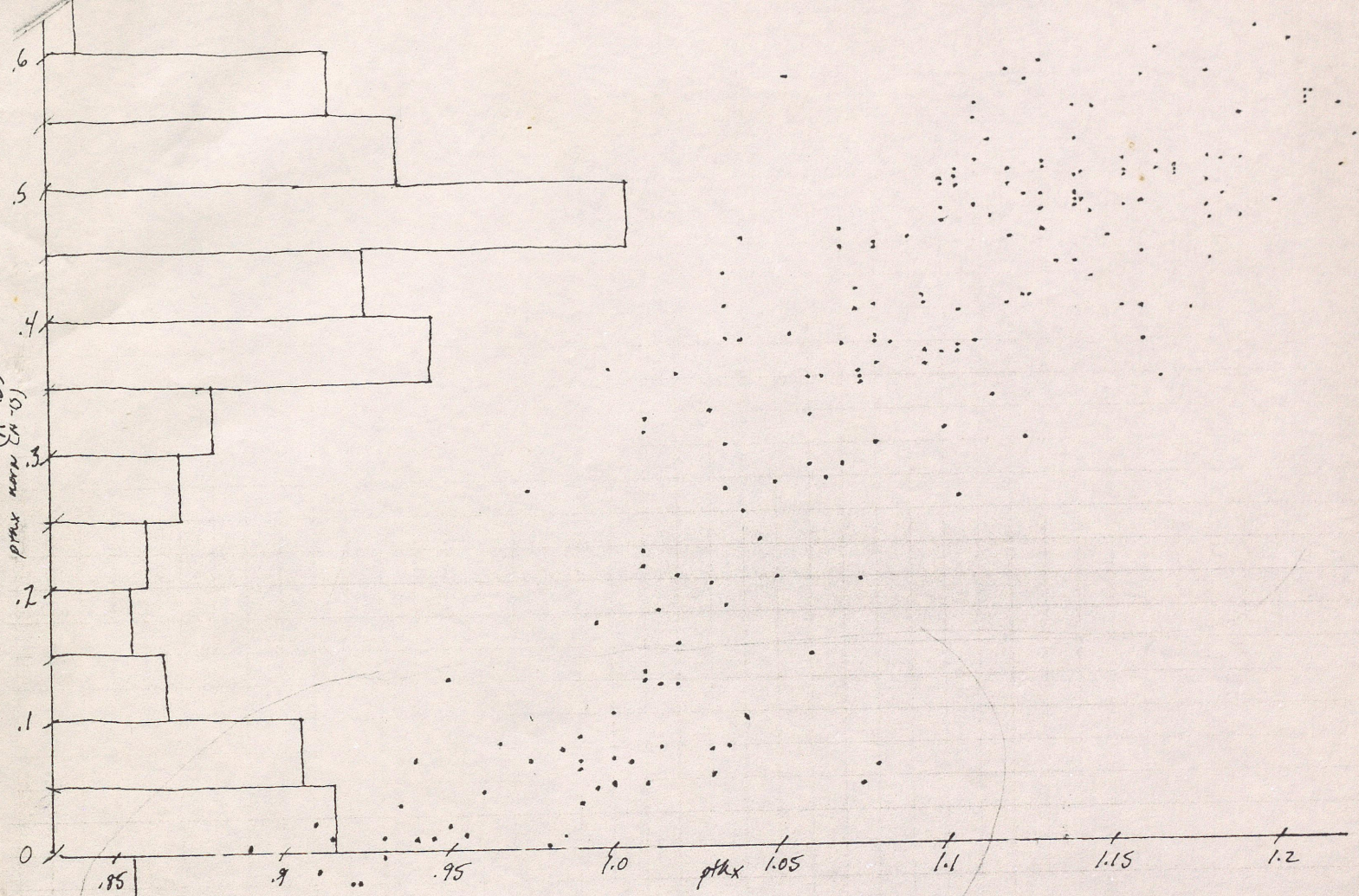
The problem arises in studies of some beetle species. I am interested in discovering if they are truly dimorphic (large forms with big horns, small ones with small or no horns) - am in the process of collecting material to make a wide survey of horned beetles in the hope of getting an idea of just how common dimorphisms really are. I am convinced that looking for double peaks in frequency distributions of characters like horn length will not work, since such double peaks could easily result from nothing more interesting than discretely different rearing conditions (say two kinds of host plant for instance, one much richer nutritionally than the other). A much more interesting way to search for dimorphism is to plot a character like horn length against some standard measure of body size. If the curve obtained is discontinuous (e.g. figure on upper left on p. 176 in the enclosed reprint), then it seems to me that one can conclude that different genetic programs are probably being used to build the different forms - a real dimorphism. My trouble comes in trying to decide whether a given distribution is really discontinuous or not. In the case of P. agenor (in the article), the difference on the graph was so dramatic that I felt free to assume that there was a real difference, but with other species the discontinuities (if they are there!) become so subtle that I am sure nobody will believe anything I say without seeing statistical tests of significance. I include the data and a graph of an example "difficult" species. Do you have any advice on how to set about proving or disproving discontinuities? I hesitate to say this (knowing my own limitations), but I think I will have to be willing to attempt even fairly sophisticated treatments if they are necessary, as the whole thrust of the project depends on my ability to distinguish polymorphisms.

Thank you in advance for any help you can give me. Please give warm greetings from both of us to Madhav, Sulochana, Ragavendra, and Geetha.

Yours,

Bill Eberhard

(A-B)
pH x norm (m²·V)

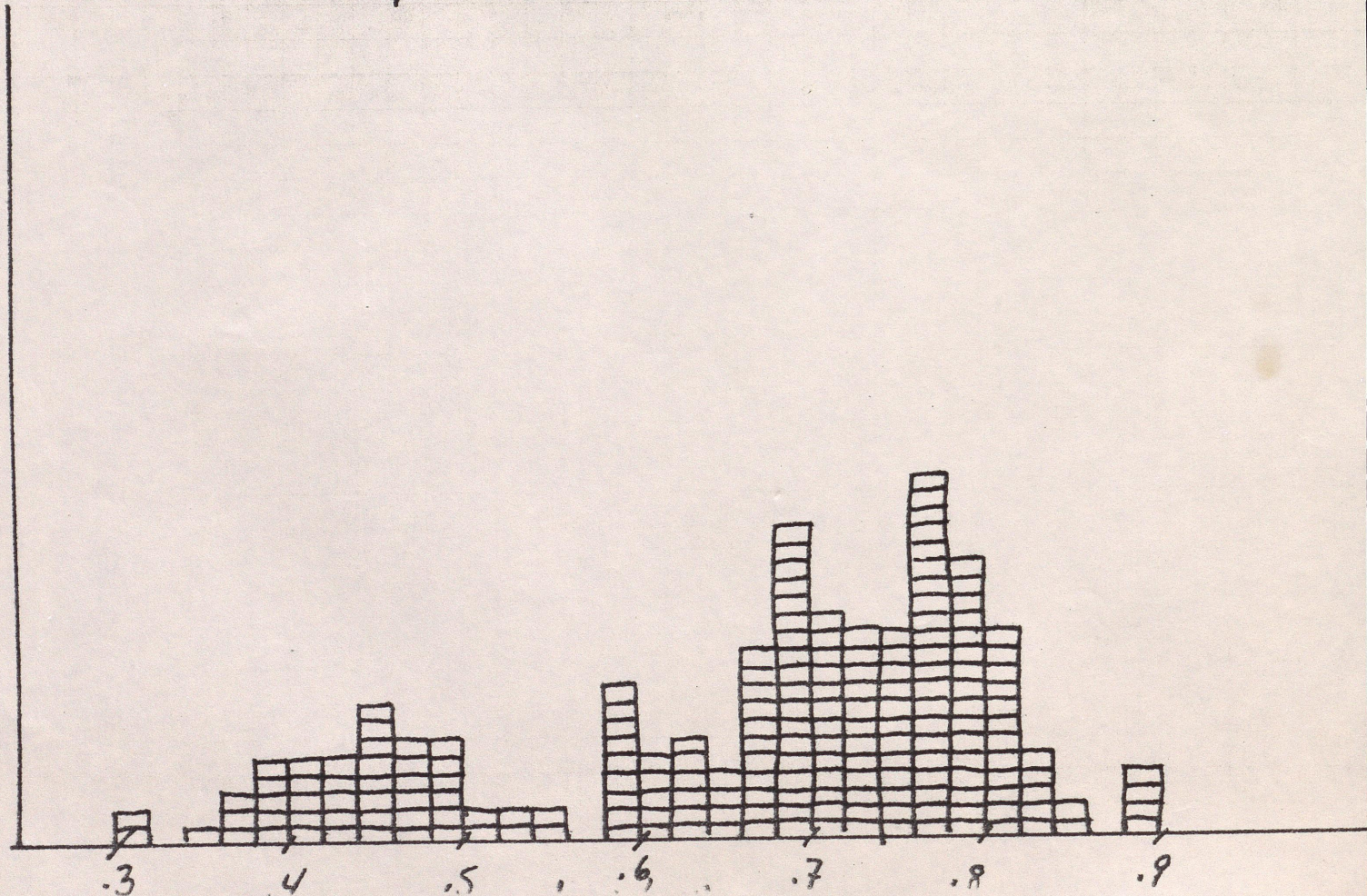
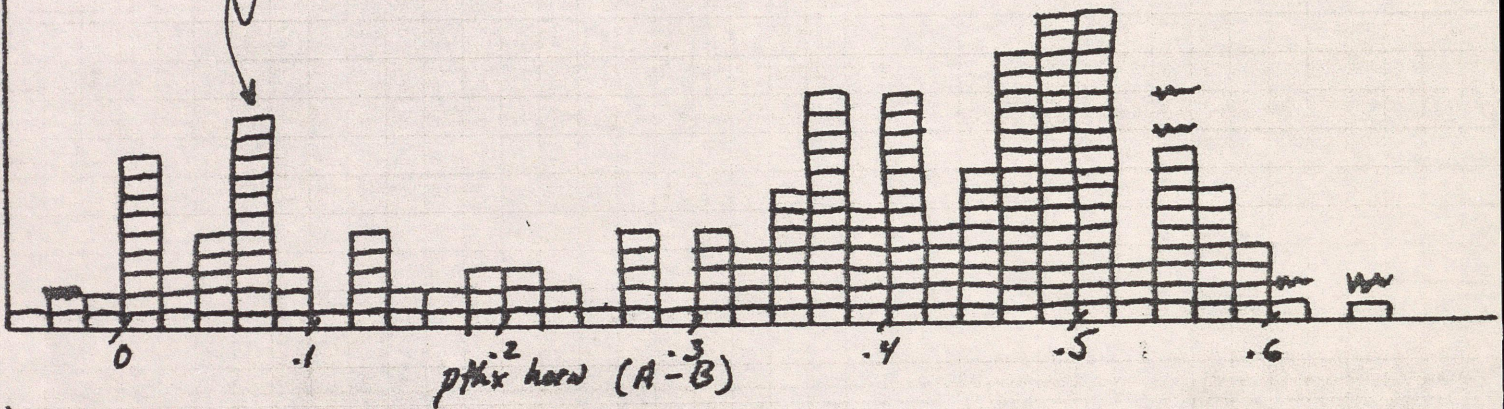
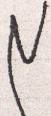


B

1.0 1.05 1.1 1.15 1.2

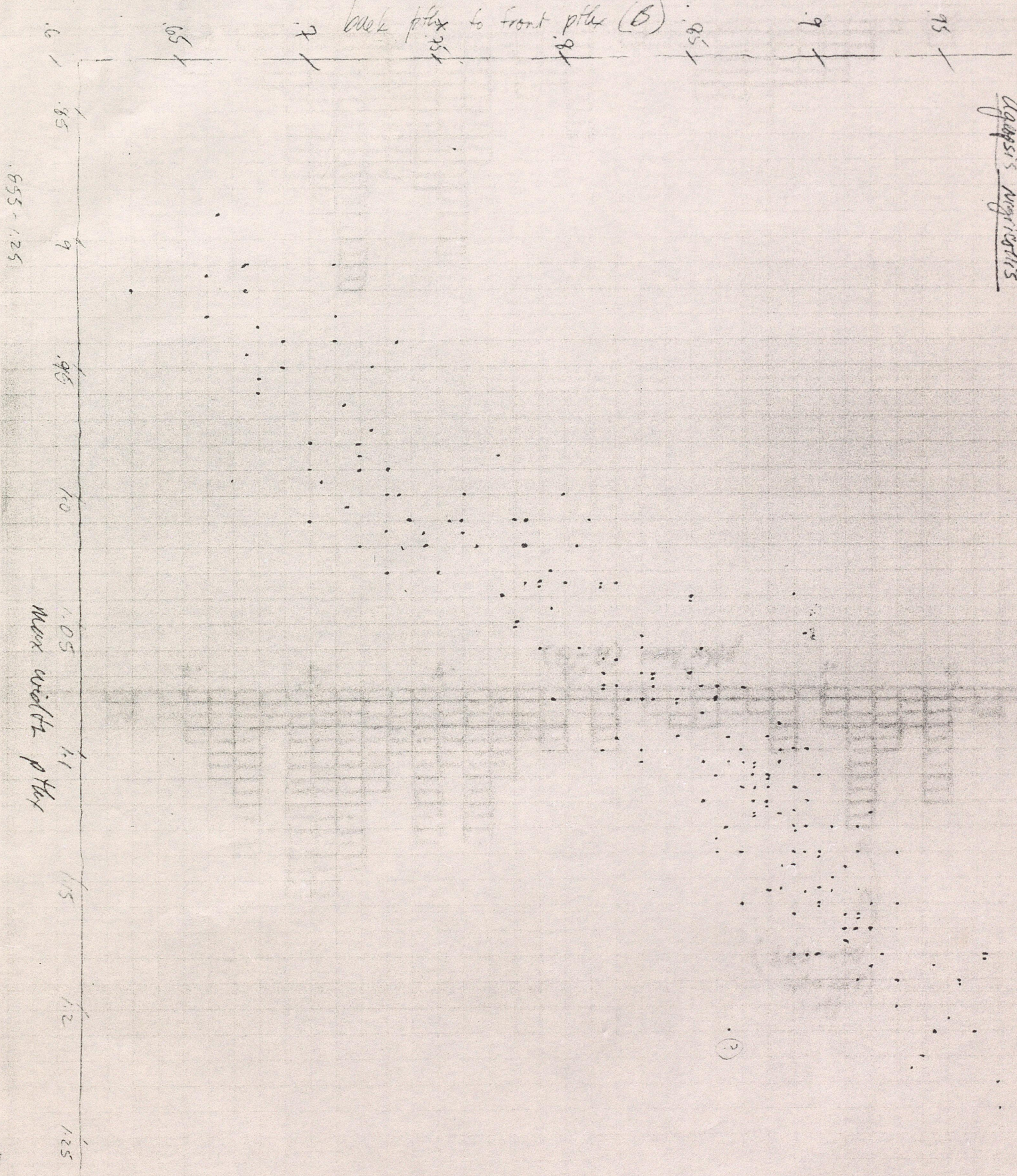
N

for
(example
.06-.079)



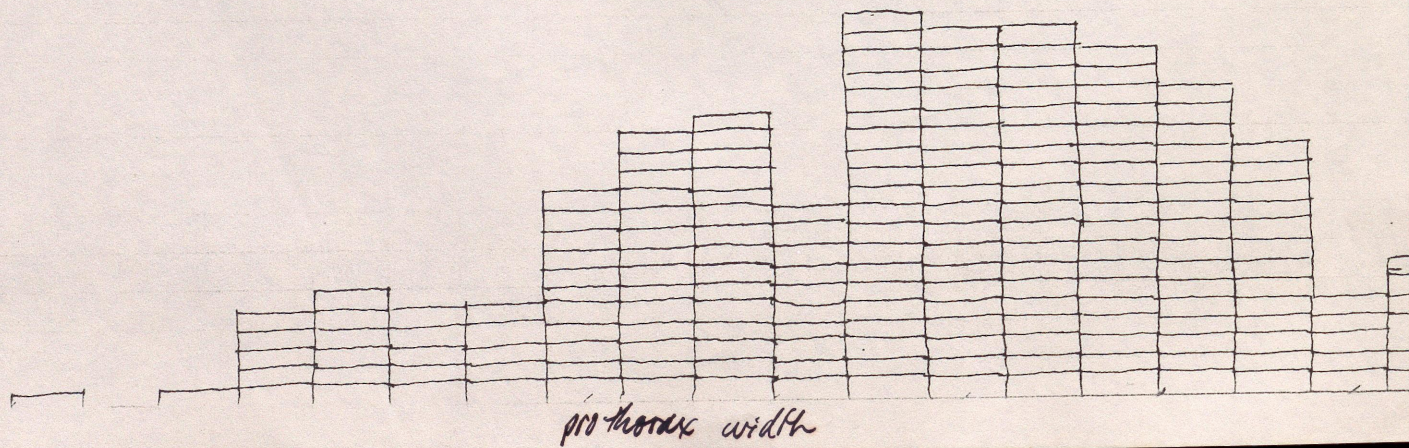
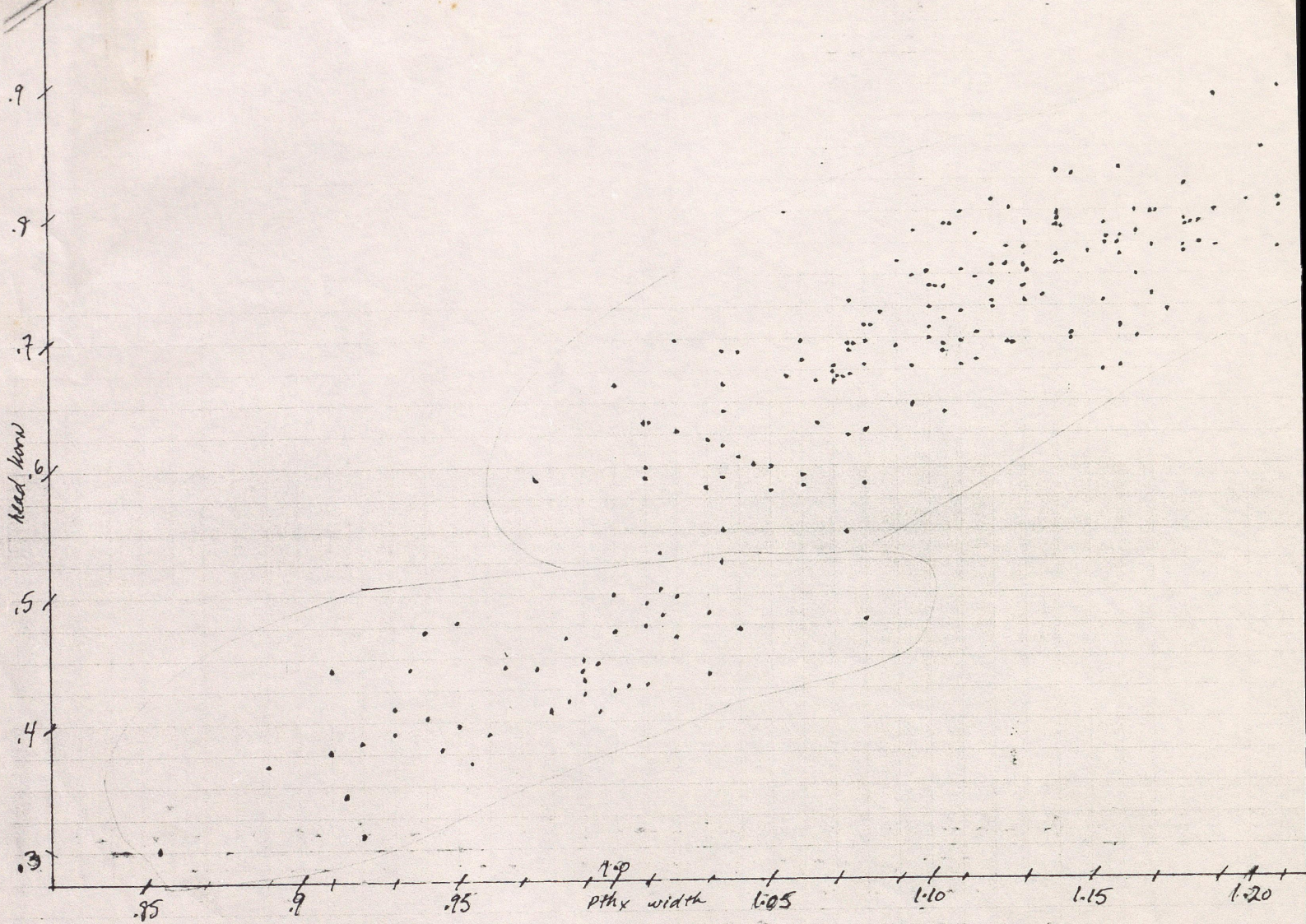
Agassiz's nigricollis

back pillar to front pillar (B)



855-125

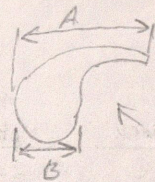
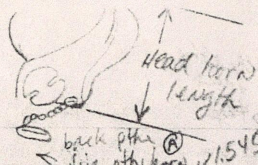
Max width pillar



Ageopsis nigricollis

sep 8

head horn	max. pthx. width	max. dist. betw. h. horns	Head horn length	back pthx. tip pthx. horn	back of pthx. to pthx. edge	measured to both tips at once
.94 .850	1.205	.765				.595
.495 .435	.990	.555				.035
.755 .670	1.055					.380
.500 .470	1.040					.095
.870 .800	1.140					.485
.845 .770	1.130					.585
.440 .410	.980					.005
.790 .740	1.120					.505
.490 .425	1.00					.045
.735 .635	1.065					.275
.835	1.140					.480
.830	1.145					.550
.760	1.130					.460
.525	1.035					.075
.755	1.100					.495
.800	1.190					.540
.700	1.145					.470
.760	1.125					.410
.790	1.140					.480
.765	1.160					.44
.635	1.010					.32
→ .890 ^{.880 .860}	1.195 ^{1.140 .95}	1.145 ^{1.185}		1.565 ^{1.570 1.575}	.950 ^{955 .955}	.61
~ .895 ^{1 horn broken}	(1.300) ?			1.540	.995	.545
.695	1.075			1.205	.855	.35
→ .440 ^{.430 .435}	1.020 ^{1.030 1.035}			.785 ^{.780 .770}	.720 ^{.720 .710}	.055
.790	1.130			1.415	.865	.55
~ .830 ^{1 horn broken}	1.220			1.550	1.000	.55
→ .590 ^{.570 .565}	.980 ^{.995 .990}	.975		.985 ^{.960 .955}	.720 ^{.710 .705}	.265
.810	1.210			1.500	.945	.555
.665	1.000			1.165	.800	.365
.465	1.020			.865	.745	.12
.685	1.060			1.175	.855	.32
.600	1.010			1.005	.785	.22
.790	1.105			1.375	.885	.49
.450	.990			.805	.720	.085
~ .810 ^{1 horn broken}	1.190			1.440	.930	.51
.730	1.130			1.380	.910	.47
.735	1.170			1.465	.910	.495
.835	1.160			1.410	.930	.48
.630	1.020			.990	.785	.205
.810	1.120			1.460	.880	.58



prothorax with its horn
(horn length taken to be A-B)

broken

Web tension machine - check 8 II n/a measure web 2178
 0 - 26.35 1 - 27.5 2 - 28.7 3 - 30.4 4 - 31.85 5 - 33.5 6 - 35.4

~~27.0 29.15 30.6 32.2 33.8
 27.0 29.1 30.5 32.2 33.7
 29.2 30.7 32.1 33.65
 32.15~~

at Night

Change: 0-1 -> 1.45 1-2 -> 1.4 2-3 -> 1.5 3-4 -> 1.45 4-5 -> 1.5 5-6 -> 1.75
 (1st test) " 1.3 " 1.3 " 1.5 " 1.7 " 1.9 " 2.0

head horn	max plate width	long plate to front plate (no horn)	long plate to front plate	
300	.855	.525	.575	-.05
.810	1.200	1.405	.930	.475
.760	1.140	1.365	.870	.495
.410	.945	.745	.705	.04
.585	1.030	.990	.795	.195
.535	1.015	.935	.760	.175
.440	.990	.795	.735	.06
.380	.945	.685	.675	.01
.470	.940	.775	.710	.065
.790	1.180	1.390	.900	.49
.440	.910	.730	.710	.02
.375	.910	.660	.675	-.015
.710	1.080	1.305	.860	.445
.675	1.155	1.280	.880	.40
.410	.930	.720	.710	.01
.680	1.095	1.210	.845	.365
.695	1.080	1.200	.820	.38
.550	1.035	.970	.790	.18
.695	1.075	1.270	.870	.40
.705	1.115	1.245	.870	.375?
.475	1.010	.880	.755	.125
.440	.935	.715	.680	.035
.720	1.175	1.305	.910	.395
.760	1.140	1.390	.890	.50
.610	1.040	1.100	.850	.25
.695	1.105	1.115	.855	.26
.680	1.070	1.210	.835	.375
.785	1.115	1.415	.890	.525
.490	1.010	.830	.700	.13
.485	1.030	.800	.730	.07
.490	1.010	.950	.740	.21

head horn	max ptfx width	back pftx to tip pftx horn	back pftx from pftx	
.710	1.160	1.270	.870	.40
.390	.930	.655	.660	-.005
.675	1.070	1.275	.830	.445
.775	1.185	1.405	.920	.485
.765	1.180	1.440	.965	.475
.465	.985	.850	.775	.075
.770	1.210	1.505	.945	.56
.440	.975	.790	.725	.065
.790	1.105	1.380	.875	.505
.770	1.190	1.380	.915	.465
.480	.950	.855	.725	.13
.795	1.140	1.440	.915	.525
.430	1.005	.780	.715	.065
.430	1.010	.805	.760	.045
.730	1.075	1.215	.860	.355
.720	1.110	1.355	.880	.475
.665	1.070	1.100	.815	.285
.740	1.130	1.405	.895	.51
.405	.940	.700	.690	.01
.695	1.125	1.180	.875	.305
.790	1.140	1.375	.900	.475
.640	1.105	1.195	.830	.365
.340	.915	.670	.660	.01
.415	.985	.730	.720	.01
.895	1.210	1.510	.960	.55
.710	1.100	1.180	.815	.365
.690	1.035	1.195	.815	.38
.770	1.180	1.330	.895	.435
.645	1.095	1.180	.820	.36
.395	.950	.705	.690	.015
.670	1.070	1.130 broken?	.850	.28(?)
~.72	1.130	1.400	.915	.485
.635	1.010	1.120	.810	.31
.705	1.145	1.310	.890	.42
.735	1.095	1.285	.880	.405
.700	1.110	1.370	.860	.51
.690	1.105	1.235	.865	.37
→ .480	1.080	.855	.795	.06
.420	.990	.765	.700	.065
.805	1.210	1.425	.865	.56

Underd. Smith - head horn w.o. pftx horn

.505	1.015	.805	.730	.075
.775	1.160			
.590	1.035	1.055	.790	.265
.690	1.040	1.230	.850	.38
.585	1.080	1.135	.835	.30
.585				
.695	1.125	1.285	.875	.41
.310	.920	.605	.630	-.025
.385	.920	.650	.675	-.025
.670	1.070	1.295	.835	.46
.365	.890	.670	.665	.005
.790	1.185	1.455	.945	.51
.680				
.750	1.095	1.275	.865	.41
.665	1.065	1.170	.820	.35
.760	1.090	1.340	.885	.455
.700	1.165	1.255	.910	.345
.745	1.115	1.340	.875	.465
.725	1.120	1.280	.875	.405
.680	1.760	1.275	.900	.375
.800	1.055	1.470	.895	.575
.740	1.105	1.370	.875	.495
.625	1.075	1.180	.835	.345
.485	1.015	.865	.745	.120
.795	1.090	1.345	.890	.455
.780	1.155	1.375	.900	.475
.680	1.110	1.255	.880	.375
.580	1.050	.980	.780	.200
.750	1.220	1.445	.940	.505
.800	1.170	1.415	.915	.500
.770	1.170	1.425	.920	.505
.775	1.155	1.380	.885	.495
.440	.965	.795	.715	.080
.685	1.115	1.215	.880	.335
.630	1.080	1.190	.830	.360
.670	1.075	1.230	.815	.415
.800	1.165	1.480	.890	.59
.765	1.150	1.360	.905	.455
.765	1.140	1.295	.860	.435
.720	1.085	1.230	.855	.375
.680	1.080	1.250	.845	.405

.790	1.180	1.465	.890	.575
.760	1.120	1.385	.895	.490
.805	1.125	1.490	.920	.570
.500	1.000	.860	.760	.100
.740	1.100	1.350	.885	.465
.800	1.110	1.455	.900	.555
.730	1.155	1.405	.905	.500
.470	1.000	.795	.730	.065
.620	1.030	1.075	.750	.325
.590	1.060	.930	.790	.140
.700	1.020	1.160	.805	.355
.715	1.105	1.265	.870	.395
.585	1.060	1.090	.805	.285
.725	1.100	1.385	.895	.490
.770				
.550	1.075	1.015	.820	.195
.755	1.130	1.395	.890	.505
.665	1.035	1.250	.820	.430
.365	.955	1.690	.680	.010
.820	1.180	1.475	.965	.510
.700	1.060	1.180	.830	.350
.600	1.050	1.050	.780	.270
.790	1.180	1.390	.925	.465
.770	1.125	1.370	.885	.485
.615	1.035	1.100	.800	.300
.850	1.225	1.460	.935	.525
.755	1.110	1.415	.875	.540
.790	1.155	1.405	.895	.510
.605	1.045	1.025	.795	.230
.675	1.080	1.220	.845	.375
.445	.995	.835	.670	.165
.740	1.100	1.305	.830	.475
.890	1.230	1.625	.970	.655
.695	1.075	1.215	.815	.400
.780	1.160	1.470	.900	.570
.390	.960	.720	.680	.040
.730	1.120	1.325	.880	.445
.750	1.165	1.430	.915	.515
.710	1.080	1.275	.825	.450
.780	1.240	1.535	.970	.565

.785	1.165	1.420	.915	.505
.735	1.135	1.295	.860	.435
.700	1.100	1.180	.870	.310
.495	1.020	.920	.765	.155
.640	1.035	1.220	.815	.405

UNIVERSIDAD DE COSTA RICA
Ciudad Universitaria Rodrigo Facio
Costa Rica, América Central

9 March 1987

N. Joshi
Indian Institute of Science
Bangalore
India

Dear Joshi,

I had hoped that on Mary Jane's recent trip to Panama she would be able to convince you to take time off to visit us here in Costa Rica. But instead she brought back the sad news that your father had died and you had returned to India. We were both saddened by your misfortune, and I wanted to let you know that you have our deepest sympathy. Deaths in the family are unavoidable parts of human life, but that does not make them easy to experience.

Please convey our greetings to Madhav, Sulochana, Rhagavendra and Geetha.

Your friend,



W.G. Eberhard