METHOD FOR THE EVALUATION OF C-BANDS HETEROMORPHISM IN HUMAN CHROMOSOMES BY IMAGE PROCESSING (I.P.).

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The I.P. method allows the C-bands computerized evaluation heteromorphisms of Y chromosome by reducing the operator variability and the measurements of the relationship between the heterochromatic region (AN) and the total chromosome area (AT).
The I.P. method (1) is articulated in the following steps: 1) image gain of each photo by camera and digitalization of analogic image; 2) interactive extraction of working area (Y chromosome); 3) preelaboration to reduce the background and to get a better contrast of digital image; 4) automatic segmentation of the specific area; 5) evaluation of AN, AT, RATIO parameters.
Eleven male subjects (94 Y chromosomes)(Tab.1) were analyzed by I.P.: all data from I.P. will be processed by a multivariate statistical method (M.S.M.).
At first we performed the outliers analysis (2) to reduce the measurement error of observator due to sensor noise, film gains, etc.
The masking effect (i.e. the inability of a testing procedure to identify even a single outlier in the presence of several suspected values) is solved by the Median test (2).
Finally we analized the data by M.S.M. (3) to identify the variables (AN, AT, RATIO) that are important for distinguishing among the groups (i.e. subjects) and to individuate among several mutually exclusive groups.
Using the discriminant score, it is possible to obtain a rule for classifying cases into one of the groups. The technique used is based on Bayes' rule.
The demonstration of maximum between group variability of C-bands heteromorphism and the minimum within group variability is obtained by the ratio eigenvalue = between group s.s./within group s.s. (Tab.2).
Infact, the coefficients of the discriminant functions are chosen so that the ratio of the between group sum of squares to the within group sum of square is as large as possible (Tab.3).
By this mathematical process we reach an exact classification for all 94 measurements (Fig.1).
Comparing the different clusters with the subjects the results was confirmed: infact, patients 1 and 2 are broters; 3 and 4 are father and son; 9 and 12 are father and son; 14 and 16 brothers, while remaining don't show any classification.
In conclusion, the results obtained from this preliminary stu-

dy are very encouraging and significative.
Therefore we programmed a further investigation both on genealogy and on population study in order to allow to introduce this methodology in forensic medicine.

TAB. 1

CL.	AN	AT	RATIO	;	AN	AT	RATIO	;	AN	AT	RATIO
1	215	576	.3732		232	615	.3772		258	669	.3856
	453	1187	.3816		303	881	.3439		460	1138	.4042
	382	1001	.3816		277	805	.3440				
2	386	879	.4391		336	815	.4122		322	729	.4417
	269	785	.3426		306	840	.3642		344	921	.3735
	361	926	.3898		320	780	.4102		282	688	.4098
3	411	986	.4168		506	1186	.4266		430	1041	.4130
	448	950	.4715		458	1030	.4446		394	905	.4353
	424	1012	.4189		409	960	.4260				
4	353	949	.3719		421	1009	.4172		399	873	.4570
	422	986	.4279		400	999	.4004		347	919	.3775
	335	879	.3811		457	1012	.4515		517	1155	.4476
	442	1166	.3790		492	968	.5082		472	1015	.4650
	372	961	.3870		429	844	.5082				
7	773	2141	.3610		1020	2319	.4398		948	2279	.4160
	908	2090	.4344		1037	2619	.3960		997	2285	.4363
	777	2061	.3770		1064	1926	.5524		663	1373	.4828
	819	1579	.5186		620	1308	.4740		695	1560	.4455
	1050	2727	.3850								
9	738	1609	.4587		841	2476	.3397		774	2536	.3052
	771	2340	.3295		673	1583	.4251		775	2391	.3241
	664	1820	.3648		1062	2872	.5673		710	2291	.3099
	610	2105	.2898		573	1675	.3420				
12	818	2246	.3642		667	1932	.3452		513	1831	.2802
	593	1710	.3468		842	2118	.3975		758	1970	.3848
13	1153	2783	.4143		1466	3868	.3790		1422	3373	.4216
	1338	3364	.3978		1407	3443	.4087				
14	1054	1985	.5310		1126	1879	.5993		1006	1782	.5645
	1196	2070	.5777		1063	1962	.5418		922	1726	.5342
16	1045	1837	.5689		1061	2579	.4114		1191	2236	.5326
	1175	2173	.5407		1187	2038	.5824		859	1603	.5359
	1181	2180	.1417								
17	1517	2891	.5247		1595	2659	.5998		1150	2438	.4717
	1319	2339	.5810		1439	2915	.4926		1708	3232	.5285
	1466	2872	.5104								

Values of the three variables AN, AT, RATIO for each case (cluster).

TAB. 2
Wilks' Lambda (U-statistic) and univariate F-ratio with 10 and 83 degrees of freedom

Variable	Wilks' Lambda	F	Significance
AN	.08001	95.44	.0000
AT	.11953	61.14	.0000
RATIO	.52126	7.623	.0000

Significance test for the quality of group means for each variable (between-groups variability). If the observed signifi-

cance level is small (less than 0.05), the hypothesis that all group means are equal is rejected.

TAB. 3

Canonical Discriminant Functions

Fcn	Eigenvalue	Pct of Variance	Cum Pct	Canonical Corr	After Fcn	Wilks' Lambda	chisquare	DF	Sig
					: 0	.0199	336.768	30	.0000
1*	11.6281	81.52	81.52	.9596	: 1	.2516	118.678	18	.0000
2*	2.5005	17.53	99.05	.8452	: 2	.8807	10.929	8	.2058
3*	.1355	.95	100.00	.3455	:				

* marks the 3 canonical discriminant functions remaining in the analysis

If the observed significance level is less than 0.05, the discriminant function is "powerful".

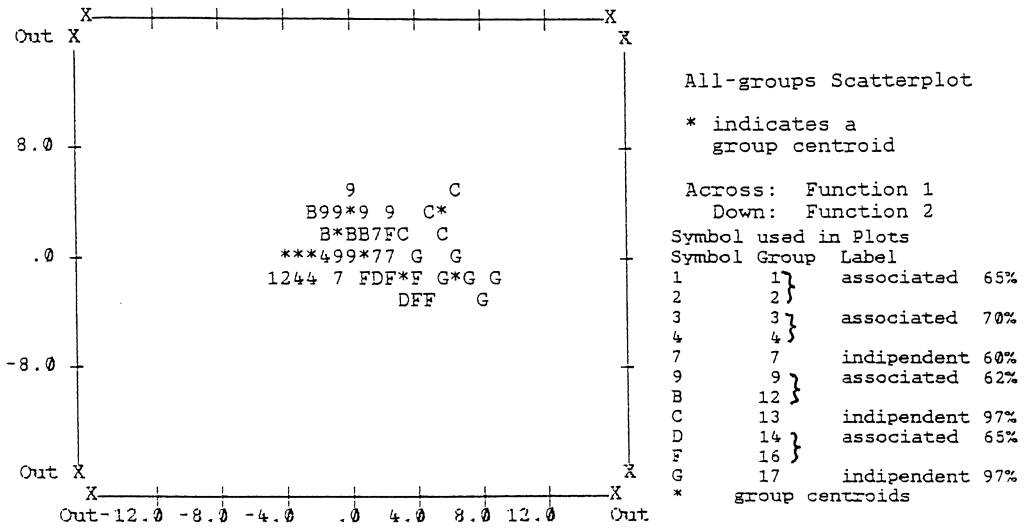

Fig.1 : Plot of the values of the two discriminant scores for each cases. Cases are identyfied by their group member. When several cases fall into the same plotting location, only the symbol of the last cases is printed.

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