NOTES

Discriminant Analysis for Mesh Selectivity Studies

One of the important criteria for judging the efficiency of a fishing gear is the size range of the fish obtained by it. Termed as selectivity of the gear, this aspect is studied with respect to the type of gear, its design and construction parameters, mesh size and the species of fish caught by it. Thus the mean length of the fish of the same species caught by gill nets with varying mesh sizes operated in the same area at the same time, gives an indication as to which mesh size can be recommended for the area. When the mean lengths do not show any significant variation between the gears, it is but natural for us to look to the other measurable characteristics of the fish to study the same. A particular case of interest is when none of the characteristics taken separately shows significant difference but if all the characteristics are considered together as in a discriminant analysis, the significance of difference may be brought out clearly. This can be so, because the discriminant analysis takes into consideration, the natural correlation existing between the different characteristics of the fish. The purpose of this note is to highlight this point making use of some specimen data. The procedure of working out the discriminant analysis can be seen in many standard text books on statistical methods (Goulden, 1959; Fisher, 1958; Rao, 1974).

The length, girth and weight of twenty fishes in set 'A' and fifteen in set 'B' are given in Table 1. The length and girth are in millimeters and the weight in grams, rounded off to the nearest multiple of 5. The measurements pertain to the fresh water fish *Catla catla* obtained from the Hirakud Reservoir caught by gill nets of two different mesh sizes, each mesh size representing one set

Table 1. *Data for the discriminant analysis*

Set A (20 observations)					Set B (15 observations)				
Sl. no.	Length mm	Girth mm	Weight g	Z	Sl. no.	Length mm	Girth mm	Weight g	Z
1	382	184	800	229	1	395	201	910	26
2	416	206	930	123	2	376	192	875	8
3	395	190	900	167	3	435	220	1000	47
4	401	198	910	112	4	418	211	950	61
5	373	180	830	171	5	464	234	1055	69
6	465	224	1050	202	6	389	197	890	43
7	447	220	1000	148	7	365	184	830	55
8	369	179	815	164	8	377	190	875	40
9	397	188	900	208	9	403	203	930	49
10	423	207	970	131	10	427	217	980	35
11	356	173	785	156	11	418	212	940	59
12	377	182	830	181	12	407	203	925	88
13	434	212	990	144	13	379	191	855	65
14	418	195	980	222	14	353	178	810	46
15	405	192	915	213	15	394	196	900	87
16	388	178	870	282	Mean values				
17	426	197	935	311	A	403.3	193.9	905.2	186
18	366	175	800	201	B	400.0	201.9	915.0	52
19	392	186	905	185	Pooled values	401.9	197.3	909.4	129
20	437	212	990	169					

of Table 1. Table 1 also gives the individual and general (pooled) means for both the sets. The 'F' test for comparison of means of 'A' and 'B' for the three different characteristics has shown that none of the differences is significant. Subsequently the discriminant analysis was tried. Table 2 gives the matrix of corrected sums of squares and products, and the equations to be solved. The right hand side of the equations are obtained by substracting the mean of set 'A' from the mean of set 'B' for each of the characteristics given in Table 1. The sums of squares and products are for the combined observations of A and B. When solved, the discriminant function obtained was

Z' : $-0.005417X_1 + 0.0076633X_2 + 0.0006406X_3$.....(1) By dividing with the coefficient of X_3 throughout and changing the sign of the right hand side,

(1) can be rewritten as

$$Z=8.4561X_1 - 11.9627X_2 - X_3 \text{.....(2)}$$

where X_1 is the length (mm), X_2 girth (mm) and X_3 weight (g) The multiple correlation coefficient R^2 with respect to (1) was 0.732517 and 'F' 28.30 with 3 and 31 degrees of freedom. This is highly significant pointing out clearly the discriminating power of the function.

The 'Z' values obtained from (2) for each fish of Table (1), calculated and rounded off to the nearest integer are given in a separate column in Table (1). The values are obtained by substituting for X_1, X_2 and X_3 the respective measurements for the fish and simplifying. The values thus obtained are conspicuously higher for 'A' than for 'B'. At the pooled means, the Z value of the function is 129 which is the discriminating point between the two sets. Verification shows that nearly 95% of the total number of fish conform to the limit, the exception being the 2nd and 4th fish of set A. Thus the discriminant analysis has brought out the significant difference between the two sets clearly where the 'F' test has failed.

Table 2. *(a) Corrected sums of squares and products*

	x_1	x_2	x_3
x_1	28,437	14,006	67,774
x_2		8,042	34,722
x_3			1,73,039

(b) Equations to be solved

$28,437\ K_1 + 14,006\ K_2 + 67,774\ K_3 = -3.3$
$14,006\ K_1 + 8,042\ K_2 + 34,722\ K_3 = 8.0$
$67,774\ K_1 + 34,722\ K_2 + 173,039\ K_3 = 9.8$
Solving: $K_1 = -0.005417$; $K_2 = 0.0076633$; $K_3 = 0.0006406$

References

Goulden, C. H. (1959) *Methods of Statistical Analysis.* Asia Publishing House, New Delhi

Fisher, R. A. (1958) *Statistical Methods for Research Workers.* Oliver and Boyd, London

Rao, C. R. (1974) *Linear Statistical Inference and its Applications.* Wiley Eastern Private Ltd., New Delhi

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