On Species Sharing Islands: Comment on an Article by S. J. Wright and C. C. Biehl

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NOTES AND COMMENTS

ON SPECIES SHARING ISLANDS: COMMENT ON AN ARTICLE BY S. J. WRIGHT AND C. C. BIEHL

Wright and Biehl (1982) address themselves to the question of whether or not a distribution of biological species may be explained as having arisen by chance. They propose a method which avoids the difficulties with the test proposed by Simberloff (1978) and Connor and Simberloff (1978). I have the impression, however, that all the problems have not been solved now, and that at least one of the remaining problems is pretty serious. Wright and Biehl's proposal, "the shared island null hypothesis" (p. 348 et seq.) runs as follows:
Let

N = number of islands having the two species;
q = number of islands having species 1;
r = number of islands having species 2;
$p(x)$ = probability that there are exactly x islands on which both species are present.

Let the species be numbered such that $q \leqslant r$, and

H_0: "the observed number of islands shared by 2 species could have arisen through random and independent colonization";
H_1: "the two species are regularly distributed over the islands."

I have some conceptual difficulties to start with. What is "random and independent colonization"? Maybe numbers of the two species move to the islands independently and at random, but circumstances are more favorable for species 1 on certain islands and more favorable for species 2 on others. When is a distribution called "regular"? Often in cases such as this, the conceptual difficulties may be resolved by looking at the mathematics. It seems that H_0 is equivalent to stating that

$$p(x) = \frac{\binom{r}{x}\binom{N-r}{q-x}}{\binom{N}{q}}$$

for Wright and Biehl propose to reject H_0 in favor of H_1 whenever

$$p^* = \sum_{x=0}^{O_{is}} p(x) < 0.05$$

where O_{is} is the observed number of islands where both species occur.

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TABLE 1

VALUES OF N, q, r AND O_{is} FROM WRIGHT AND BIEHL (1982) ACCORDING TO MY FIRST INTERPRETATION

Taxonomic Group	N	q	r	O_{is}
Ptilonopus	29	11	20	2
Pachycephala ...	26	12	14	0
Macropygia	20	6	14	0
Lacerta	46	18	28	0

TABLE 2

COMPARISON OF p-VALUES ON DIFFERENT INTERPRETATIONS

		p^* ACCORDING TO		
TAXONOMIC GROUP	WRIGHT AND BIEHL (1982)	Interpretation 1	Interpretation 2	INTERPRETATION 2 WITH 6 MORE ISLANDS
Ptilonopus	.000325	.00000549	.000334	.00843
Pachycephala .	.000338	.000000104	.00338	.00904
Macropygia ...	.0245	.0000258	.0245	.0543
Lacerta	.000000111	.000000000000355	.000000111	.0000000000684

Just to check whether I had understood the proposal, I tried to reproduce the calculations leading to the p-values in Wright and Biehl's table 1 (p. 350). The N's, q's, r's, and O_{is}'s I read from their table are given in table 1. What I think is important are the values of N. I read "N = number of islands colonized by two species." Now there are 18 islands with species 1 from the genus *Ptilonopus,* 9 with species 2, and 2 with both species; so 18 + 9 + 2 are colonized by two species, i.e., $N = 29$. Furthermore, species 1 is found on 18 + 2 = 20 islands and species 2 on 9 + 2 = 11 islands, therefore $q = 11$, $r = 20$, $O_{is} = 2$. From these data, I tried to compute p^*. For the case of *Ptilonopus,* for example:

$$p^* = \frac{\binom{20}{0}\binom{9}{11} + \binom{20}{1}\binom{9}{10} + \binom{20}{2}\binom{9}{9}}{\binom{29}{11}} = \frac{\binom{20}{2}}{\binom{29}{11}} = 0.00000549.$$

I also computed the other p^*'s this way. The results are given in the second column of table 2, while Wright and Biehl's values are reproduced in the first column. It turns out that I must have misunderstood Wright and Biehl's definitions. The fact that in their table 1 they also give a number of islands on which neither species occurs suggests that they might have included these in N, for why mention irrelevant data? There were three islands on which neither species of *Ptilonopus* occurred, so perhaps N should be 32 not 29. Of course, my p^* then would be wrong; for *Ptilonopus* it should be

$$\frac{\binom{20}{0}\binom{12}{11} + \binom{20}{1}\binom{12}{10} + \binom{20}{2}\binom{12}{9}}{\binom{32}{11}} = 0.000334.$$

I also computed the other p^*'s this way. The results are given in table 2, third column. Again, the results differ from those of Wright and Biehl, but there are now similarities so striking that I think we must seriously consider the possibility that the differences are due to computational errors. If this is accepted, then my second interpretation is the correct one.

Suppose, however, that neither of the species concerned occurs on a number of other isles. For example, I think it is likely that they are not present on any of the Dutch Wadden Isles: Texel, Terschelling, Vlieland, Ameland, Schiermonnikoog, and Rottum. Although it would be extremely difficult to check this without destroying the islands, let us assume it for the sake of the argument. As there are six more islands now, we may further increase the N's to 38, 49, 39, and 63, respectively. The resulting p-values are given in the fourth column of table 2.

It seems to me that the test proposed by Wright and Biehl is useless, for by adding or deleting islands we may obtain any p-value we like. The test, therefore, gives no information on the question whether or not species outcompete each other. In searching for appropriate statistical techniques, one has to realize that whether or not an investigator will find representatives of a species on an island depends on a large number of things apart from the colonization process, and interspecific competition.

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