

Dews, D. University of Oregon, Eugene, Oregon. A model for frequency-dependent mating success.

in *D. persimilis* by Spiess and Spiess (1969). These workers have found that when the ratio of two competing types is varied, the minority male type is often more successful than the majority male type. The types may differ by a mutation, by a chromosome inversion, by geographical region of collection or by development in different environments. Spiess (1968) has suggested a mechanism based on male-male interference to explain minority male advantage in which either male type has an advantage when rare and one type has an advantage when the two types are in equal numbers (case I). Spiess and Spiess (1969) note that this sort of mechanism does not explain the case in which both types have an advantage when rare and mating is random when the two types are present in equal numbers (case II). They suggest sense organ "adaptation" as a possible mechanism. Recently Ehrman and Spiess (1969) report that minority male advantage is eliminated in the top of double chambers if either rare type pairs or rare type males are in the bottom chamber. They conclude that male-male interactions seem to be ruled out in favor of the females' "recognition" of the relative frequency of the two male types. Ehrman (1969) has shown that mating success can be changed by air-borne stimuli.

This note presents a model which seems to be able to accommodate the various types of frequency-dependent mating advantage reported in the literature. The courtship behavior of the male must have a number of components which stimulate the female. Contact stimuli (chemical and mechanical) and distance stimuli (visual, air-borne chemical and air-borne mechanical) have been suggested by Spieth (1968) and others. It seems reasonable to expect two types differing by a mutation, by a chromosome inversion, by geographical region of collection, or by morphological or physiological features arising from development in different environments, to be quantitatively different with respect to at least several of the components of courtship. The first postulate of the model is that at least two components (x and y) of the male's courtship are present at different levels in each of the two competing types (A and B). The second postulate is that the female's level of excitation is increased by the male's continued delivery of the courtship components; when the level of excitation of both components reaches some threshold, she accepts the male courting her at that time. The third postulate is that the maximum component of the two lines must not be the same.

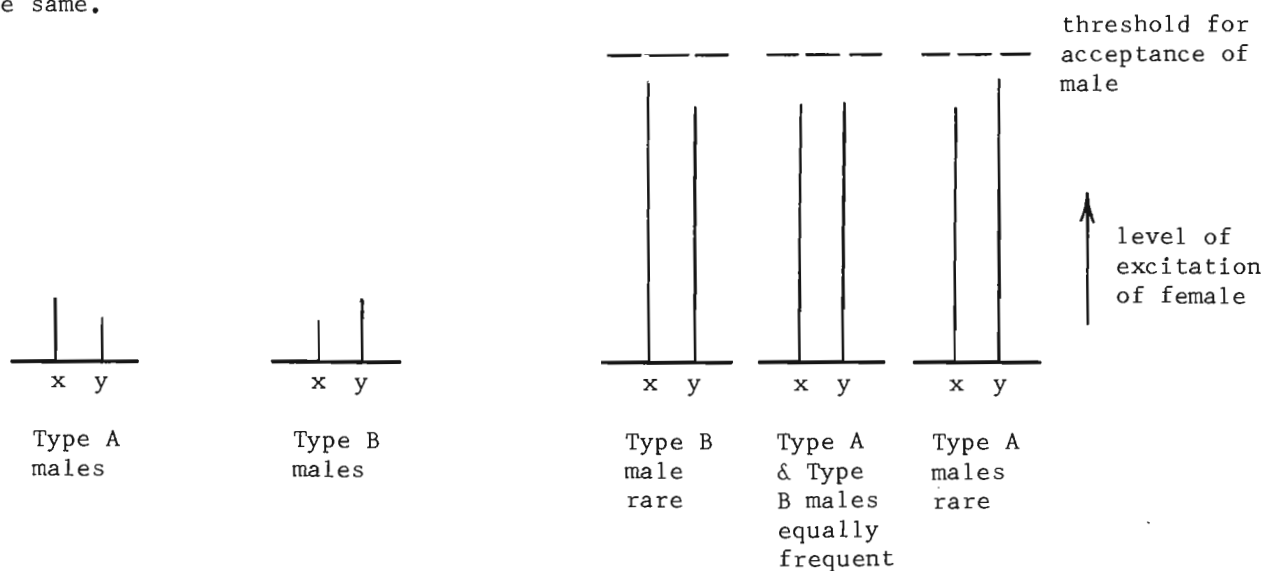


Fig. 1a. Postulated levels of two female-stimulating components (x & y) of male courtship (case II).

Fig. 1b. Level of excitation of female after several courtships.

If type A males have higher x but lower y components than type B males and if the difference between the x components of types A and B is about equal to the difference between the y components of types A and B (see Fig. 1a), then the model predicts case II. When type A males are common and type B males are rare, a common type A male is more likely to court a given female than is a rare type B. After some time type A males will have furnished threshold or near-threshold amounts of stimulation in component x, but component y will not yet be near threshold. At this time (see Fig. 1b) the rare type B male is more capable than the common type A male of raising component y to the threshold level and so is more likely to be accepted by the female. If we change the frequency of the two types of males such that type B is common and type A is rare, we get (after some courtship activity has occurred) the y component near threshold and the x component not yet near threshold. At this time a rare type A male is more capable than a common type B male of raising component x to the threshold level and so is more likely to be accepted by the female. When the two male types are equally frequent, the levels of a female's x and y components will rise towards threshold at an equal rate. Neither male type will have an advantage. An example of case II was reported by Ehrman (1966) with the mutant delta in competition with wild type.

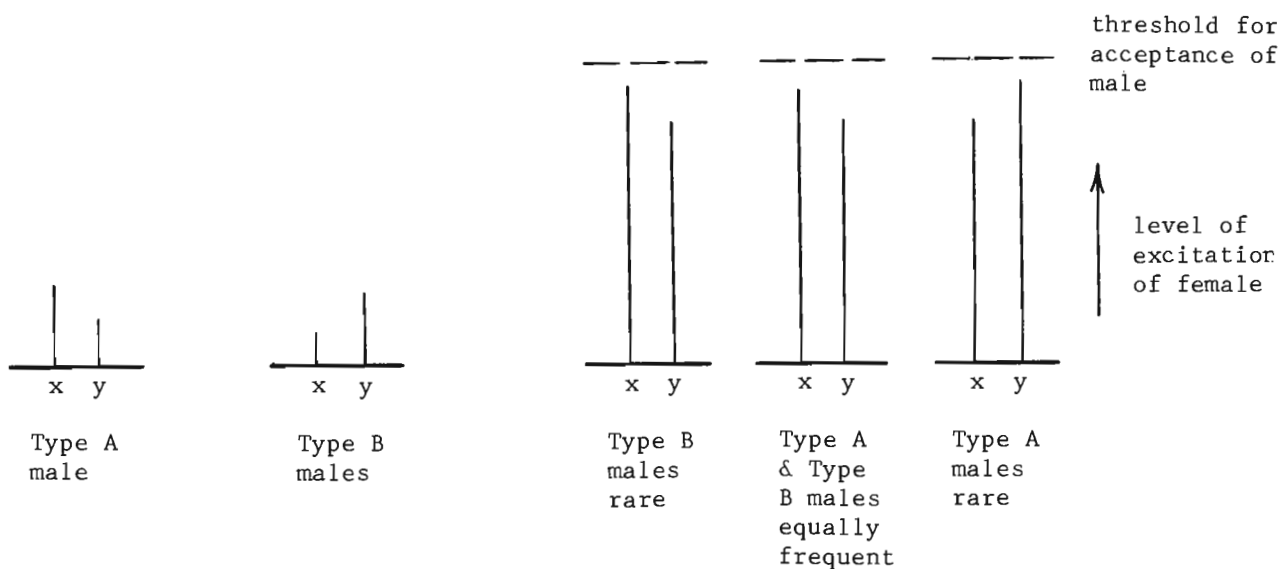


Fig. 2a. Postulated levels of two female-stimulating components (x & y) of male courtship (case I).

Fig. 2b. Level of excitation of female after several courtships.

If type A males have higher x and lower y than type B males (as before) but the total amount of stimulation provided by type A males is somewhat greater than that provided by type B males, then case I is expected. An example was reported by Ehrman (1966) using AR/AR raised at 16° and 25°C.

A third case giving two possible outcomes seems possible if type A and B males have equal y but unequal x components (case III). As before the maximum component of the two lines must not be the same. The prediction in this case is that when type A males are rare they have an advantage and that when type B males are rare, mating is random. When the two male types are present in equal numbers, there are two possible predictions: (1) If the total x of types A and B is greater than the total y of types A and B, then mating is random (see Figs 3a & 3b). (2) If the total of the x of types A and B is less than or equal to the total y of types A and B, then A males are expected to have an advantage (see Figs 4a & 4b). An example of case III(2) was reported by Ehrman (1966) using the mutant orange and wild type.

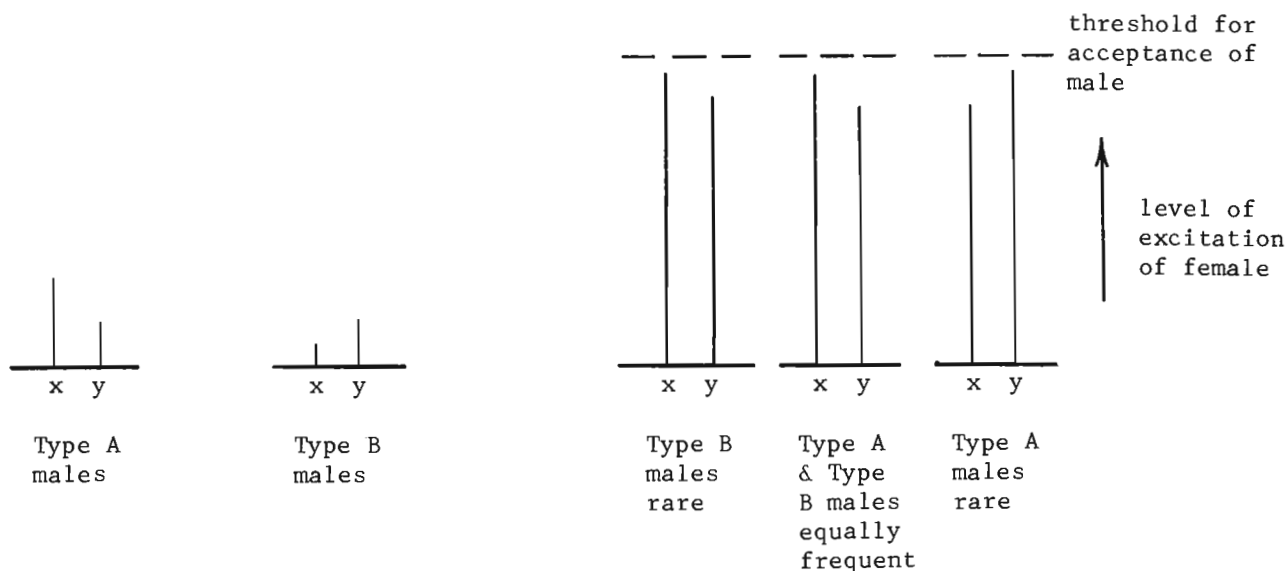


Fig. 3a. Postulated levels of two female-stimulating components (x and y) of male courtship (case III (1)).

Fig. 3b. Level of excitation of female after several courtships.

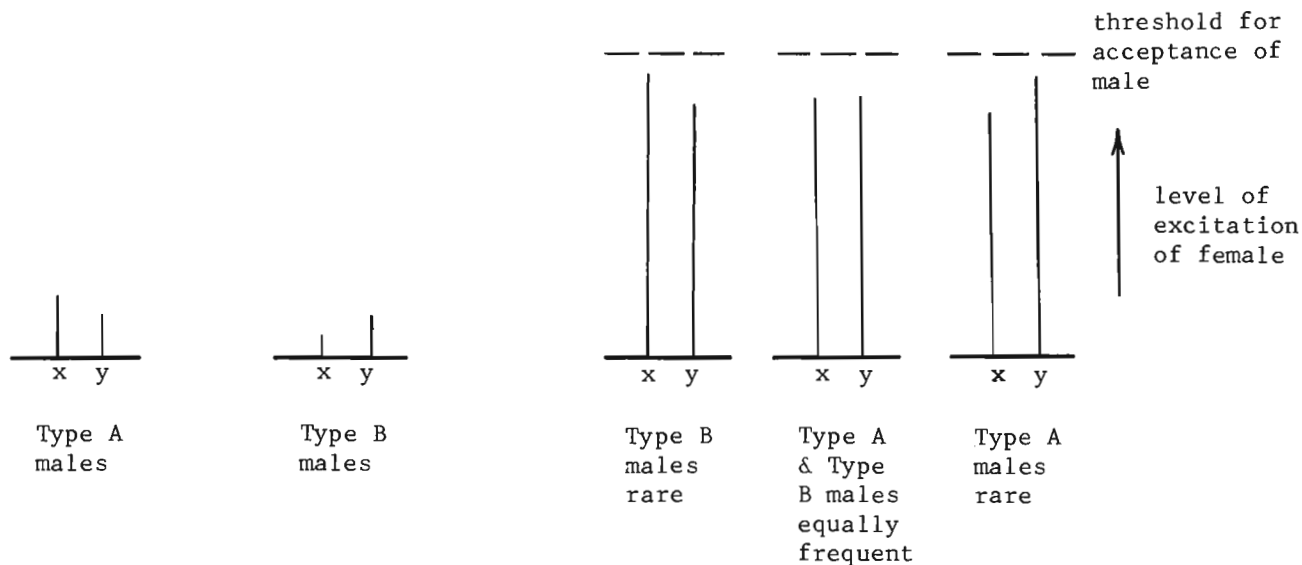


Fig. 4a. Postulated levels of two female-stimulating components (x & y) of male courtship (case III (2)).

Fig. 4b. Level of excitation of female after several courtships.

References: Ehrman, L. 1966, *Anim. Behav.*, 14: 332-339. Ehrman, L. 1967, *Amer. Natur.*, 101: 415-425. Ehrman, L. 1968, *Genet. Res.*, 11: 135-140. Ehrman, L. 1969, *Evolution*, 23: 59-64. Ehrman, L., and C. Petit, 1968, *Evolution*, 22: 649-658. Ehrman, L., and E.B. Spiess (1969) in press. Petit, C. *Bull. Biol.* 92: 248-329. Spiess, E.B. 1968, *Amer. Natur.* 102: 363-379. Spiess, L.D. and E.B. Spiess, 1969, *Amer. Natur.* 103: 155-172. Spieth, H.T. 1968, *Evolu. Biol.*, 2: 157-193.