

which I argued against, and I cannot see that by doing so I have "over-stated my case".

The analogy I drew between the behaviour of human societies and close physical assemblies, like crystals (not, as Prof. Simey writes, "communities of crystals"), was meant solely to demonstrate that the co-operative phenomena working in both these cases are of a similar nature. For the fundamental assumption made is only that a strong 'interaction' of some sort or another is taking place; whether this interaction is of a conscious or an unconscious nature is not essential for the characteristic features of a co-operative phenomenon.

If the proposed model is indeed a reasonable representation of human society, various measures, introduced in the past for strengthening social communities, appear to be founded on unsound principles and are bound to produce the opposite effect. It was in this connexion that I mentioned the political stability of the United Kingdom; but I never intended more than to make a very modest contribution towards the understanding of this stability.

I quite agree with Prof. Simey that the value of statistical mechanics for the social sciences will have to be established by extensive experiments, although I am not sure whether such communities as a factory working group or a housing estate are sufficiently large assemblies to justify the proper use of the theory of co-operative phenomena. I should be quite satisfied if my paper induces social scientists to undertake such experiments.

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I AM much reassured by what Dr. Fürth has said, since he has made it clear that his intention was to object to the 'indiscriminate' application of statistical methods to social problems, rather than to suggest that the use of those methods was necessarily misleading. I do not, in fact, see much evidence of misuse of statistics in this way by my academic colleagues; but I agree that less-sophisticated people are often led into errors of this kind, and it is useful to point it out.

Dr. Fürth has performed a valuable service in directing attention to a mathematical 'model' which has not so far been made use of in the interpretation of social phenomena. But I can only reassert my view that it would be a retrograde step if we were to allow ourselves to argue by analogy, and to conclude as a result that "various methods, introduced in the past for strengthening social communities, appear to be founded on unsound principles and are bound to produce the contrary effect".

The value of these suggestions needs to be tested by experiment and observation; but the possibility of doing so appears to be somewhat remote when doubt is cast on the value of using the working population of a factory or the inhabitants of a housing estate as the material of an experiment, on the ground that their numbers are not sufficiently large. Dr. Fürth must tell us more about the minimum numbers which would be significant for this purpose, and throw more light on the methods which might be used to achieve it.

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Non-adaptive or Neutral Characters in Evolution

SEWALL WRIGHT¹ has shown that, given certain ecological conditions, drift will occur and produce an apparently random pattern of variation. Some authors have thereupon employed genetic drift, in the same way as adaptive neutrality was formerly employed, to explain every example of variation which in their opinion is random. This procedure is wrong. They have not proved drift to be acting, but have failed to prove that selection is acting, and have invoked drift to cover the failure. An explanation which depends for its success on the failure of the investigator cannot be regarded as satisfactory.

I do not claim, as Carter² states, that we must now accept that there is no evolution of non-adaptive—or neutral—characters in Nature. Such a claim would be as difficult to maintain as the claim that genetic drift is common and important. Probably drift does occur, to some extent. But every example of it so far adduced either rests on the logical fallacy pointed out above and in a previous communication³, or remains uninvestigated, or has been disproved on further investigation. The more the interactions between genes and their environments are studied, the less likely does it become that genes controlling definite characters can possess, except perhaps for very short periods, the very low selective coefficients necessary for extensive drift.

It seems, therefore, that in view of the complexity of living systems and their environments, the investigator should be cautious and not use drift or selective neutrality as an explanation for all unanalysed cases. As Carter² points out, what is wanted is more investigation; but it is doubtful whether any example of variation in Nature can be so completely analysed that, after selective effects have been estimated, the residual variation can be ascribed with confidence to genetic drift. There is always the possibility, indeed the likelihood, that the analysis of selective effects was not complete.

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¹ Wright, S., *Genetics*, **16**, 97 (1931); "The New Systematics", 161 (London, 1940); *Evolution*, **2**, 279 (1948).

² Carter, G. S., *Nature*, **168**, 700 (1951).

³ Cain, A. J., *Nature*, **168**, 424 (1951).

I AM glad that Cain admits that genetic drift may be a real factor in evolution, even though he may not be willing to admit that its effect is significant. Since I have not wished to express an opinion on the relative importance of selection and drift, it seems that the only point at issue between us is that I do not accept the present evidence as being so strongly against drift that we should not, when dealing with some types of evolutionary change—especially trivial changes in micro-evolution—regard it and selection as equally possible explanations when neither is proved. If we do so regard them, it seems as much a fallacy to assume selection alone where there is no disproof of drift, as to assume drift wherever there is no proof of selection. If in any case analysis of selective effects is incomplete, this fact cannot be used as evidence against drift as the efficient cause.

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