

BIOLOGICAL ORGANIZATION

THE biologist is faced with many different but interdependent levels of organization in the systems which are his concern—systems which range from the smallest living particles, like genes and viruses, to the large aggregates denoted as populations and communities, including human society. In his address to Section K (Botany), Prof. K. Mather points out that genetics and cytology have shown us how the nucleus is organized for the perpetuation and recombination of the hereditary materials. They are beginning to show us, too, how the gene is organized as a unit of action depending for its characteristic mediation of a complex biosynthetic process on the arrangement of its parts in a special spatial pattern. The remainder of the cell, conventionally covered by the title of cytoplasm, is an aggregate of materials, processes and even systems, the properties, origins and maintenance of which are extremely varied. The mitochondria may well provide a mechanical basis for at least part of the cytoplasmic organizations; but balanced action here must depend more on chemical equilibration than mechanical control as it does in the nucleus.

The nucleus provides the firm foundation on which cytoplasmic balance can be built; but the cytoplasm can react back on to the nucleus, as indeed we see in fungal heterokaryons, where the genic balance is adjusted by cytoplasmic alterations of nuclear division. Nucleus and cytoplasm are thus complementary and inseparable in cellular organization, one securing the constancy needed for control and the other the flexibility needed for adjusted action. In somatic differentiation this adjustment is related between the cells, some differences being built up and others suppressed to give the characteristic patterns of development. Its success depends on the ability of a constant nucleus to stimulate and manage a changing cytoplasm.

Each cell is at once a complex organization in itself and a specialized part of the higher organization which we term an individual. Individuals in their turn are parts of the organizations which we term populations, within which they are tied together by functional relations in reproduction (as in dioecy, heterostyly, etc.), protection, survival or the maintenance of genic balance. Being functional, these bonds may tie together as collaborators in one function individuals which are complete and therefore competing units in respect of other functions. Individuals of different species may be tied functionally in symbiotic organizations.

All organization, at its many different levels, depends for its origin and survival on the efficient division of labour among the parts (which may themselves be organizations at another level) in the discharge of some function. These parts may be bound together temporarily or permanently by a wide variety of means—morphological, physiological and behaviouristic. Any organization must have the property of continuation or recurrence; this is secured at the genic and nuclear levels by reproduction as wholes, the daughter being already a replica when it parts from its mother, and full continuity being thereby secured from the start. Some parts of the cytoplasm secure their own reproduction in the same way, but others are built up only in certain circumstances, so giving

the characteristic versatility and capacity for change. The repeatability of pattern in this change is governed by the continuous organs of the cell, especially the nucleus. Some continuing parts of the cell may, however, have entered it initially by infection, depending for perpetuation on their own heredity, now part of that of the cell.

The cellular organization of nucleus and cytoplasm provides the basis necessary for somatic differentiation, nuclear control having developed in such a way as to replace opportunistic responses by ordered changes of the cytoplasm in large measure divorced from the immediate external environment. The organization of populations and the differentiation of individuals within them similarly depend in the general case on the nucleus, which often here has the added function of switching development into its different individual paths by genic segregation. Populations differ from somata, however, in that they may be propagated characteristically by a gradual replacement of parts, so that new members may be adjusted by the action of old ones, as is, for example, the case where some process of learning is involved. In symbiosis each component must depend on its own genetic balance for continuing adjustment, but this must be governed by relations external rather than internal to the individual nucleus. The symbionts must also be endowed with some means of securing their co-ordinated distribution in propagation. This may be secured by the activity of one partner in carrying the other with it, but other means may well also be possible. The mutual adjustments of symbionts, especially their genetical adjustments, offer an important and virtually untouched field of investigation.

No organization is immutable. Changes are continually occurring in the controlling genes. The alterations are mostly degradatory and are weeded out by selection, which may result either from the direct competition of other units of organization at the same level—for example, of cell with cell—or from the failure in competition of a higher organization because of the deficiency of its parts—for example, the failure of an individual because of maladjustment of its cells. Occasionally, however, change will lead to a more efficient organization which will then be at an advantage in selection. Genetical evidence is unanimous that all the complexity of biological organization and its control has arisen in this Darwinian fashion.

Human society differs from most biological organizations in that continuity and control have come to depend on education (in the broadest sense) rather than heredity, though the underlying genetical requirement is still there. This process of education resembles infection rather than heredity in its properties and offers new opportunities while posing new problems. The controlling laws, customs and so on are subject to change, and have undoubtedly evolved in the competition of individuals, communities and societies in the past. The character of this selection is, however, no longer like that of biological levels, and we are seeking to control it. In doing so, we must not forget that our society is but another level of organization superimposed on all the biological systems below it. To flout the principles common to them all and to shut our eyes to their interactions could lead only to disaster.