

reviews

Algal genetics

Lynn Margulis

The Genetics of Algae. Edited by Ralph A. Lewin. Pp. viii+360. (Blackwell Scientific: Oxford and London, 1976.) £11.50.

THIS book is a beautifully edited and profound review of the state of genetics of algae, which, as Lewin says, "are more of a guild than a clan, united more by common aptitude than by common ancestry". Although all algae have been taken to be within the province of the work, in fact there is very little serious genetics on organisms other than the green algal genus *Chlamydomonas*.

There are thirteen separately authored sections in the book. These include reviews of the recently established field of the genetics of blue green algae, the formal (mainly nuclear, mendelian) genetics of *Chlamydomonas reinhardtii*, genetic determinants of flagella phenotype in *C. reinhardtii* (a frustrating subject to study since flagellar alterations in these organisms which mate 'flagella first', tend to impair the frequency of viable crosses) and a short chapter on the genetics of cell wall formation in *C. reinhardtii*. The cell wall summary not only indicates how useful mutational analysis ultimately may be in the deciphering of the complexities, chemical and ultrastructural of cell wall morphogenesis, but indicates that there may be still another enigmatic "non-mendelian genetic system" in this chlorophyte.

C. reinhardtii, of course, is the star actor in any eukaryotic cell genetics drama and this is aptly indicated in the two chapters by Gillham, Boynton and their colleagues on plastid inheritance and genetic control of ribosomal biogenesis. The relationship of the three genetic systems (nuclear, plastid and mitochondrial) has nowhere been better investigated than in this rapidly growing isogamous organism, which may be mated at will, completes its life cycle in about a week and for which gene dosage and genotype-phenotype relationships can be studied since stable diploids can be made.

Information concerning the genetic systems of *C. moewusii* and *C. eugametos*—two other species of *Chlamydomonas* rivalling *C. reinhardtii* for centre stage—is reviewed. Since

stable heterokaryons can be made in *C. moewusii*, complementation can be studied in this organism. The reason why 2 amino-3 butanoic acid induces both gene mutation and chromosomal aberration in *C. eugametos* is still obscure. No such effect has been seen in *C. reinhardtii*. Other differences between the three species have been noted as well, providing internal tests for the possible generalisation of observations made on *C. reinhardtii*.

Although an exciting comprehensive, and up-to-date treatise, this book makes us acutely aware of how limited our genetic knowledge is concerning the algae as a group. There literally is no genetic literature as such on the red algae, the brown algae, the diatoms, the dinoflagellates, the chrysophytes, the prasinophytes, the euglenids, the haptophytes, and so forth. Although there is some scattered information concerning the mating and differentiating systems in *Volvox*, conjugating green algae, 'multicellular marine algae' and *Acetabularia* in chapters on the genetics of the Volvocales, Zygnematales, and Charophyta, respectively, even these sexual green algae have managed to hold on to their genetic secrets.

The classical techniques of controlling the life-cycle of marked genetic stocks, crossing individuals of opposite mating types and measuring the distribution of traits in offspring of these crosses are simply not available in the vast majority of algae for several different reasons. For example, the genetics of an organism such as *Euglena gracilis*, a flagellate which has yielded significant information concerning mitochondria and chloroplast inheritance and development, is impossible to study. Although chloroplast development and differentiation can be induced, these fast growing single cells simply refuse to mate. Thus, all of these chapters referred to above are forced to deal with "genetically related" phenomena (for example, hybrids produced by grafting in *Acetabularia*, nucleic acids of organelles).

Furthermore, the book is overwhelmingly concerned with the eukaryotic green algae: the Chlorophyta. As for the Cyanophyta or blue greens, they are a world apart. True to their popular new name (Cyanobacteria) they are

only rudimentarily sexual, anything at all about genetics is known in very few species. In general, they rely on proven prokaryotic mechanisms for gene transfer—transformation and transduction—in so far as any occurs. One new realisation is the nature of the circular genetic map as deduced from mutagenesis studies in synchronous cultures of *Anacystis nidulans*, a coccoid blue green: it really resembles in overall features, the genetic map of *Escherichia coli*.

Some idiosyncratic but profound algal genetic anecdotes come to light in this well illustrated and produced book. For example: in some blue greens recombination seems to be regularly accompanied by mutation; in *Ulva* the chromosomes are apparently composed of four rather than two DNA strands, and in *C. eugametos* a specific mutator gene reverses mutations at two nicotinamide loci.

Probably the most exciting advances concern the unravelling of biochemical interactions between the three classes of genetic organelles in *C. reinhardtii*: nucleus, mitochondria and plastids. Indeed sex in organelles exists and genetic maps have been made of a cytoplasmic genetic system. (Presumably these maps are of the chloroplast linkage groups: recombination of plastid DNA has been discovered.) There is even some evidence that a single mutation may alter both chloroplast and mitochondrial ribosomes simultaneously. Several chloroplast ribosomal proteins are apparently synthesised on cytoplasmic ribosomes even though the chloroplast DNA probably codes for all the chloroplast RNA.

The book is full of such well explained surprising genetic phenomena, and is highly recommended for advanced genetic and phycology courses and the professional reader. *The Genetics of Algae* is indispensable to those interested in genetic systems of the 'lower eukaryotes'. The book is well written, comprehensive and comprehensible. If more work on the other fascinating algal groups has not been reported here, it is because it has not yet been done. □

Lynn Margulis, Professor in the Department of Biology at Boston University, is on leave as Sherman Fairchild Distinguished Scholar at the California Institute of Technology, Pasadena.