

pass more rapidly through their life-cycle, and their numbers may be more drawn upon by the abundant animal life; consequently considerable additions to their apparent total may be necessary, if we wish to estimate properly the importance of plant life in the tropics, as compared with that in higher latitudes. We must remember, moreover, when dealing with observations made in coastal waters all the year round, that the different species have a natural periodicity that may be connected with unknown internal factors in their cycle of life, as well as with the influence of currents which at one time carry the surface-layers away from the coast and at another time towards it. All the same there are many irregularities which cannot be explained as being solely the result of the actual physical conditions of existence. Besides light and warmth we might perhaps be apt to think of salinity, which, in the course of its variations, influences both the density and the osmotic tension of the sea-water. Though we are aware that a low or greatly varying salinity is injurious to many pelagic organisms, there are others which thrive remarkably well and multiply exceedingly under such conditions, as for instance the diatom *Skeletonema costatum* and the peridinean *Ceratium tripos* forma *subsalsa*. Results, in fact, are often the reverse of what one might expect. The flora of brackish-water bays, which is poor in species, may develop into even greater masses than we find synchronously in the open sea, where no osmotic changes have disturbed the vital activity of the numerous species belonging to the community of oceanic algæ.

We cannot get away from the view, which was first confidently put forward by Brandt, that certain indispensable nutritive substances occur so sparsely that, according to Liebig's minimum law, they act as factors which limit production. Liebig found that the growth of plants on land depends on the amount of the requisite nutritive substances present, the determining substance being the one of which at any moment there is least in proportion to the needs of the plant. As long as a particular nutritive substance occurs "in minimum," plant production will be proportionate to the available quantities of it, even though there be a superabundance of all other essentials.

If this law is made to include all necessary conditions of life, it will be found to apply universally to all organisms both on land and in the sea, in which case that condition of existence, whether it be physical or chemical, which occurs "in minimum," will be the factor of limitation. We must remember, however, that produc-

Brandt.

Liebig's
minimum law.