mechanism developed by Osborn between 1893 and 1918, that all typical organisms depend upon the typical action, reaction, and interaction of the four complexes of energy, physical, chemical, mechanical. Secondly, (*a*) Darwin's selection principle, whereby all organisms are constantly standardised in their adaptive actions, reactions, and interactions; (*b*) subsidiary to this, the Osborn-Baldwin-Morgan principle (1896–1898) of "coincident selection," whereby through heritable potentialities of self-improvement, self-adaptation, etc., every race of organisms is not only standardised but also constantly improved; (*c*) the negative of Darwin's principle, the "cessation of selection" or panmixia of Weismann, whereby there is a gradual recession of unused or less used organs from a dominant to a subsidiary position in the life of the organism, finally to retention only in the germinal stage; (*d*) the internal bio-mechanism of selection, the "intra-selection" of Roux, whereby every element in the developing organism also has to contribute its quota or decline.

While intensive observation by palæontology of successive genetic phyla of organisms demonstrates that the chief selection principle of Darwin is constantly operating in the rise and decline of all adaptive bio-mechanical organs, the subsidiary fortuitous selection hypothesis as originally conceived by Darwin leaves the greater part of the bio-mechanical evolution process entirely unaccounted for. While we palæontologists observe great currents of continuous bio-mechanical adaptation which are actually going on in the heredity germ-plasm, we find no evidence either of chance or of discontinuity in the whole domain of bio-mechanical evolution. The surface ripples of fortuity as observed in De Vriesian mutation and the occasional waves of heritage variation observed in botany, zoology, experimental embryology, and genetics do not blind us to the continuous adaptive bio-mechanical evolution of each organism, even to the minutest bio-mechanical detail in each organ.

This statement is borne out in a recapitulation of the chief bio-mechanical principles of adaptation formulated from the time of Aristotle and of Empedocles to the present time, five of which were first observed in zoology and confirmed in palæontology, the remaining four principles having been observed only in palæontology.

(*To be continued.*)

Periodicities and Predictions.

AN interesting paper by Prof. Axel F. Enström, Director of the Academy of Engineering Science, Stockholm, under the title "On Periodicities in Climatic and Economic Phenomena and their Co-variation," deals with the important question of extrapolating past climatic and economic data in order to predict future conditions. In his introduction the author claims that "an investigation along these lines of the coal prices and the general prices" published by him in 1913 has been justified by the prediction of an economic boom about 1918 and a depression with the bottom about 1922. But it is doubtful whether this success really affords a corroboration, for these events must have been mainly controlled by the termination of the War, and were forecasted by methods independent of such an upheaval.

It is rather surprising that the author "earnestly warns" his readers against the "absolutely unreliable" process of drawing a mean straight line through a graph of annual values and producing it; for the advantages and disadvantages of the method lie on the surface, and there are occasions when it may give useful information.

Prof. Enström points out that the ordinary plan of smoothing, say by 5 years, effects a bigger reduction in the amplitude of the shorter periods than it does in the longer: on the other hand, if we subtract each term of a series from the next the series of differences is free of secular change and the amplitudes of terms of short period grow by comparison with those of long period. So when he is examining the temperature of London in relation to a period of about 9 years, which he calls the ϕ period, he smooths with respect to periods of 2, 3, 5, 11, and 13 years, and takes differences three times: and in order further to bring out the ϕ component he subtracts from the resulting series that got by smoothing over 9 years; he then applies an elaborate correction (including a smoothing by 19 years) for the sake of the residual terms. As we should expect after so much selective treatment, the graph is strikingly cyclic, though there are irregularities; and the author's conclusion is that the ϕ period is "not a homogeneous sine-wave of constant wave length but possibly a compound wave": there is, however, no comparison of the amplitude with what would be given by a purely accidental set of data, and no Fourier analysis of the periods between 8 and 10 years. The question whether the period is compound is left unsolved.

In order to obtain a real basis for extrapolation in regard to the future, it seems clear that the series must be replaced by a number of harmonic terms, and extrapolation can only be made when it is shown that the series of harmonic terms gives a fair approximation to the original. The analysis of Prof. Enström appears rather complicated for the small amount of definite information that it provides regarding Fourier periods in the neighbourhood of 9 years.

A further departure is made in relation to "co-variation." After determining curves for the ϕ periods of two quantities in the manner already described, the correlation coefficient between these curves is obtained: as might be expected from the inevitable similarity, high coefficients are derived when the data of one curve are advanced or retarded so as to produce coincidence of phase: and obviously it is misleading to speak of these results, got by a process that in general removes most of the character from the original curves, as if they were derived direct from the originals themselves. Thus it appears very unlikely that the variations of the yield of wheat in France are to any serious extent controlled by the length of the world's railways or control them; but by working out the ϕ curves of these two quantities and moving the latter forward two years a coefficient of 0·82 is produced which Prof. Enström considers as "indicating a very high degree of correlation."

The working out of possible periods exercises great fascination on many minds, and trustworthy information regarding them is of decided value to science. But Beveridge's complete working out of the periodogram of wheat prices in western Europe led him to the conclusion that prophesying was not possible on the facts as he gave them; and Brunt's equally thorough investigation of Greenwich temperature led to a similar conclusion. Disappointment seems inevitable unless great care is exercised before domination by periods is announced, and we hope that the insight and industry of Prof. Enström will find further scope in their elucidation.