enough ionization in the solar disk for magnetic effects to be enough to stabilize it. Mr Cremin (Reading) discussed evidence gathered from an investigation of young clusters.

PALAEONTOLOGY

Patterns in Evolution

from a Correspondent

THE 1968 meeting of the Palaeontological Association was held from December 17 to 19 in the Department of Geology, University of Southampton, under the chairmanship of the president, Professor A. Williams. The subject of the meeting was "Patterns in Evolution".

As might have been expected, "pattern" was often equated with morphology, and morphological change was correlated with either geological age or palaeo-environment. Dr R. M. C. Eagar (Manchester Museum) interpreted the morphology of certain non-marine lamellibranchs from the Coal Measures as adaptations to turbulent and tranquil environments and justified this by reference to the shape of recent bivalves living in such conditions. Dr E. P. F. Rose (Bedford College) similarly related the morphology of some Tertiary echinoids to palaeoenvironmental regimes.

Morphology as a function of geological time is the basis of biostratigraphy. There were reports of new work on the evolution of Lower Silurian graptolites (Dr R. B. Rickards, Cambridge, and Dr J. E. Hutt, Leicester); Lower Carboniferous conodonts (Dr R. L. Austin, Southampton) and the root stock and descendants of *Gryphaea arcuata* (Dr A. Hallam, Oxford). These three contributions were linked by the problem of homoeomorphy—the production of similar morphologies in distantly related stocks either more or less contemporaneously or at different geological times. Because morphology is the principal, and often the only, criterion whereby the palaeontologist deduces biological affinity, the evolution of such deceptively similar forms can play havoc with attempts to reflect genetic affinity in fossil taxonomy. Moreover, used in reverse, it can lead to false deductions of the geological age of the enclosing strata. In the graptolites described, the hooked condition of the theca was shown to have developed in different lineages, independently, at much the same time. In the case of the conodonts, increasingly used for stratigraphic correlation, fusion of nodes led to deceptively similar forms at different horizons and to a potential trap for unwary biostratigraphers.

The value of the ammonoid suture line, and especially its ontogenetic development, as a guide to biological affinity was urged by Dr J. Wiedmann (Tübingen). In discussion, this paper revived the long standing controversy as to the value of a single morphological character for deducing lines of evolution. The ultrastructure of the shell in different groups of branchiopoda was described by Professor A. Williams (Belfast) aided by remarkable electron micrographs. Here again, similar patterns of shell structure had arisen independently in the otherwise unrelated Craniaceae and Strophomenaceae at about the same time. The evolution of the molluscan shell structure was also outlined by Dr J. Taylor (British Museum) and Dr W. J. Kennedy (Oxford).

Taking a different line, Dr K. A. Joysey (Cambridge) related the changing global composition of fossil crinoid faunas in terms of the relative abundance of the major groups. Using recent taxonomic reviews and stratigraphic ranges together with radiometric dating of the strata, he computed "life expectancy" curves but indicated some subjectivity due to the degree of taxonomic "splitting" involved in the fortuitous monographing of different groups.

Dr A. H. Smout (British Petroleum Research) sought to describe cephalopod coiling mathematically by adding terms to the formula for the equiangular spiral to account for major and minor departures from this simple mode of coiling during ontogeny. Professor F. Hodson (Southampton) investigated goniatite suture lines by Fourier analysis and showed a rough parallelism between the ontogenetic complication of this feature and the pattern resulting from successive incremental addition of higher harmonics. No biological meaning was ascribed to the mathematical parameters in these formulae.

INSECT DEFENCES

Handling Dangerous Chemicals

from our Entomology Correspondent

INSECTS and related arthropods utilize for self protection highly toxic substances of diverse kinds, among which quinones are probably the most frequent. The well known bombardier beetle *Brachinus crepitans*, for example, ejects a hot mixture of several *p*-benzoquinones. The inner chamber of the defensive gland contains a mixture of diphenols and hydrogen peroxide; this mixture is passed to the outer chamber where catalase is added and the liberated oxygen converts the diphenols to quinones in an explosive exothermic reaction and the product is thus violently ejected. This mechanism was described by H. Schildknecht and K. Holoubek. More recently, T. Eisner and his colleagues have shown that the millipede *Apheloria corrugata* emits a mixture of benzaldehyde and hydrogen cyanide from its defensive glands. The final step in the production of these two toxicants is the hydrolysis of the precursor benzaldehyde cyanohydrin which takes place in a special outer chamber of the cuticular reservoir.

How have insects acquired the ability to manufacture these small, intensely reactive and toxic molecules without injury to their living cells? In a recent paper from Eisner's laboratory, G. M. Happ (*J. Insect Physiol.*, **14**, 1685; 1968) develops the idea that the pre-adaptations which make this possible are already present in the insect integument. The insect epidermis is accustomed to producing phenols which are oxidized to quinones in order to tan the outer regions of the cuticle. All that is required is that the precursor substance should be stored in extracellular compartments or reaction chambers, along which they can be transmitted as on a production line and exposed to the additional reagents needed for the final steps in the biosynthesis of the toxicants.

The tenebrionid beetles *Tribolium castaneum* and *Eleodes longicollis* possess defensive glands which produce a mixture of benzoquinones, unsaturated hydrocarbons and caprylic acid. The glands may consist of one or two cells, each enclosing a large secretory vesicle; within this vesicle, detached from the cell, is a cuticular organelle. This organelle furnishes the "reaction chamber" for the final dangerous steps of manufacture. A plausible hypothesis is advanced by