Cretaceous ammonites

from M. K. Howarth

AMMONITES are an extinct group of Cephalopods that flourished during the Mesozoic era 240 to 65 million years ago. Their world-wide distribution and speed of evolution, reflected in distinctive shell features, makes them the most useful macrofossils in the Mesozoic for relative dating of rocks. Rock divisions representing time intervals as small as about one-third of a million years can be recognized.

Ammonites from coastal exposures of Upper Cretaceous rocks in Zululand and Pondoland in South Africa are splendidly illustrated in a recent work by Klinger & Kennedy*. Abundant representatives of the subfamily Texanitinae were found in two areas 350 miles apart. Careful stratigraphical collecting showed that in each case there are complete series of transitions between the same four successive species, two of the ancestral *Texanites,* two of the successor *Submortoniceras.* Although the four species showed very high variability in both areas, there are small consistent differences between the same species in the two areas that are held to be of subspecific rank. It seems that the two populations were sufficiently isolated geographically to maintain these subspecific differences, but contact between them was enough to ensure that they evolved in parallel in specific and generic characters.

In the past ammonite systematics became unnecessarily complicated as generic and specific divisions were multiplied without any agreed method of control. This description of South African Upper Cretaceous ammonites is a good example of the new methods that have been applied during the past 25 years, involving accurate stratigraphical collecting and the use of single bed assemblages as a control to the species classification. It has been found repeatedly that the considerable morphological variation that has to be admitted to ammonite species, embraces many species and even genera of past ammonite systematists.

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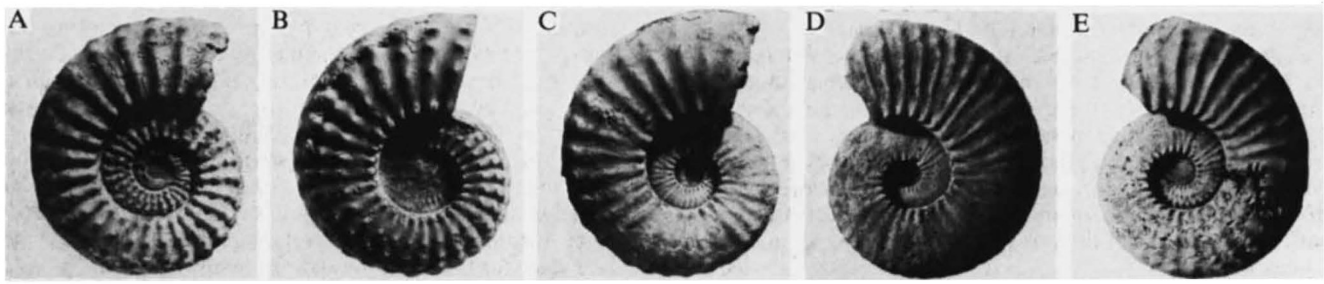
A — *Texanites presoutoni* sp. nov.; B — *Texanites soutoni* (Baily); C — *Submortoniceras woodsi* (Spath); D — *Submortoniceras condamyi* (Collignon); showing progressive evolution from A, the oldest, to D, the youngest. E — *Submortoniceras woodsi (Spath).*



show that it is almost certainly the muscle that induces acetylcholine synthesis in the Schwann cell. The identity of the inducing factor(s) is, here, as elsewhere, unknown.

It is an exasperating fact that while the chemical mediators of induction in embryos remain unknown, most of the known and characterized growth factors discovered through assays *in vitro* have no well established role *in vivo.* The most recently discovered of these factors is a component of the brain and pituitary that causes proliferation of Schwann cells and astrocytes *in vitro*[14]. Brockes has now raised a monoclonal antibody against it, which will make it possible to purify and sequence it; and to discover what, if any, its function is *in vivo.* □

1. Jacobson, M. *Science* **155**, 1106 (1967).
2. Gaze, R.M., Feldman, J.D., Cooke, J. & Chung, S.-H. *J. Embryol. exp. Morph.* **53**, 39 (1979).
3. For brief summary see Robertson, M. *Nature* **278**, 778 (1979).
4. *Neurosci. Res. Prog. Bull.* **17**, (1979).
5. Fawcett, J.W. *J. Physiol.* **306**, 32P (1980).
6. Horton, J.C., Greenwood, M.M. & Hubel, D.H. *Nature* **282**, 720 (1979).
7. Scholes, J.H. *Nature* **278**, 620 (1979).
8. Cowan, W.M., Rogers, L.A. & Kelly, P.J. *J. comp. Neurol.* **155**, 127 (1974).
9. Lance-Jones, C. & Landmesser, L. *J. Physiol.* in the press.
10. Stirling, R.V. & Summerbell, D. *Nature* **282**, 640 (1979).
11. Lewis, J. *Zoon* **6**, 175 (1980).
12. Le Douarin, N.M. *Nature* **286**, 663 (1980).
13. Miledi R. & Slater, C.R. *Proc. R. Soc.* Lond. B **169**, 289 (1968).
14. Brockes, J.P., Lemke, G.E. & Balzer, D.R. jun. *J. biol. Chem.* **255**, 8374 (1980).

Solar oscillations

from H.B. van der Raay

KNOWLEDGE of the Sun, our closest star, is based on observations of its surface properties. The temperature, magnetic field and constituents of the outer layers can be deduced by spectroscopy and, combining these data with estimates of size and mass, a model of the Sun's properties can be formulated. The model fits not only the observed surface properties but also predicts interior characteristics such as density and temperature. From these parameters and rates for the nuclear fusion reaction which converts hydrogen to helium and provides the energy output of the Sun the number of solar neutrinos associated with the nuclear burning may be readily found. An experimental verification of the standard solar model thus became possible. Unfortunately, as is well known, the experiment designed to detect these solar neutrinos failed to record the numbers predicted.

An alternative way to probe the solar interior is by the detection of solar oscillations in a manner analogous to terrestrial seismology. The pressure waves associated with the oscillations, especially if of long period, penetrate deeply into the solar interior and convey information about the internal structure. Here again observations and predictions from the standard model appear contradictory. Does this imply that the theory is incorrect or is it the interpretation of the observations that is at fault?

Long period oscillations of the sun were discovered by Birmingham[1] and Crimean[2] groups, working independently, in 1976. Both groups measured the line of sight Doppler shifts of certain Fraunhofer absorption lines and, since observations were made on the integral solar disk, concluded that these observations corresponded to simple radial oscillations of the sun. The measured period of 160 minutes raised an immediate conflict with the standard solar model since if these were simple radial oscillations the longest period predictable was approximately 60 minutes. The Cambridge theorists[3], however, pointed out that the observations could be interpreted in terms of more complex *g* mode oscillations.

Since these early observations, studies of line of sight velocities of the solar surface have continued. The Crimean group have found evidence that the 160 minute oscillation has persisted to the present day

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with the same phase, although with a substantially decreased amplitude. This is confirmed by a group working at Stanford[4]. The Birmingham group have, however, failed to confirm this result and find many long period oscillations which vary in period, phase and amplitude from one day to the next[5].

All these observations necessarily suffer from the fact that the sun is only visible for part of the day and, as a consequence, the data sets are modulated by a 24 hour period. Any periods found which are harmonics of a day thus need to be considered most critically. 160 minutes is exactly 1/9 of a day — could this oscillation appear simply as the result of the method of analysis? The Crimean and Stanford groups, aware of this possibility, point out that the period is now found to be 160.01 minutes.

At the other end of the time scale are the five minute oscillations first discovered by Leighton in 1960. A detailed study of this region over some three years by the Birmingham group[6], showed that these five-minute ($\backsim$3mHz) oscillations had a well defined structure and consisted of >20 well defined discrete frequencies with a mean spacing of alternate lines of 135.6μHz. Interpreting these data in terms of the then current solar models Iben and Mahaffy[7] and Christensen-Dalsgaard *et al.*[8] suggested a heavy element abundance $z \backsimeq 0.004$ in contrast to the standard model value of $z = 0.02$.

The solution to the 24 hour modulation problem may be found in three ways: (a) by placing many observation stations around the globe, (b) by observing at one of the earth's poles, (c) by operating from a suitable space satellite. Each of these solutions have both advantages and disadvantages: (a) would require redundancy at any given longitude to overcome weather problems, (b) is subject to atmospheric effects as the sun is always close to the horizon, (c) includes all the technical problems associated with a space program. Also the costs involved increase rapidly as one proceeds from (a) to (c).

The polar solution has been taken by Grec *et al.* and is described in this issue of *Nature* (see p.541). The stresses of an austral summer were amply rewarded by the results of an excellent experiment which resulted in 120 hours of uninterrupted observations. The preliminary analysis confirms the detailed structure and spacing found in the five-minute oscillation. However, those data relating to the longer periods do not show convincing evidence for the existence of a 160 minute oscillation. It is only when a superposed epoch analysis similar to that used by the Crimean and Stanford groups is used that the 160 minute period emerges. Admittedly the 24 hour modulation associated with daytime observation is no longer present in these data, but the earth does still rotate about its axis once every 24 hours, even at the pole. Hence any instrumental or atmospheric effects would have to be clearly eliminated.

Interpretation of the five-minute structure depends on the assignment of the modes observed. All the Doppler shift measurements are strongly biased to low order modes since the integral disk is observed. Hence it is customary to assume l_0, l_1 . . . modes, where l_0 is the simple radial oscillation l_1 alternate radial and axial expansions and contractions and higher l values correspond to more complex shape deformations. Once l has been assumed then for a given frequency ν, the number of radial overtones, n, may be estimated and the results compared with theory.

In a revival of the standard solar model Christensen-Dalsgaard and Gough present a paper in the present issue of *Nature* (see p.544), in which the standard value for the heavy element abundance is retained, $z = 0.02$, and the observational structure of the five-minute oscillations is fitted by taking into account the effect of the solar atmosphere. However it is clear from the models listed that these are very insensitive to the observed frequency separation. Indeed it appears that the only significant change in $\Delta\nu$, the frequency separation, occurs when low z values are considered. At the recent Eslab symposium[9] a mean spacing of 135.2 ± 0.2μHz was reported which would still appear to favour the $z = 0.004$ value. A direct comparison of the predicted frequencies with the 25 which have now been measured to an accuracy of $1:10^3$ may yield a more conclusive test as to which model to use.

All interpretation of the data depends critically on the correct identification of the mode concerned. This may be experimentally determined by considering two dimensional observations of the solar disk. Such work is at present in progress[10] and will hopefully resolve any mode identification problems. The experimental observations of independent groups have firmly established the discrete structure of the five-minute oscillations although the mode identification and reconciliation with theory is still unsatisfactory.

Clearly if we do not understand our own closest star, the implications on the whole field of cosmology are enormous, and continued efforts by both theorists and experimentalists are urgently required.

1. Brookes, J.R., Isaak, G.R. & van der Raay, H.B. *Nature* **259**, 92 (1976).
2. Severny, A.B. Kotov, V.A. & Tsap, T.T. *Nature* **259**, 87 (1976).
3. Christensen-Dalsgaard, J. & Gough, D.O. *Nature* **259**, 89 (1976).
4. Scherrer, P.M., Wilcox, J.J., Kotov, V.A., Severny, A.B. & Tsap, T.T. *Nature* **277**, 635 (1979).
5. Brookes, J.R., Isaak, G.R. & van der Raay, H.B. *Mon Not R. astr. Soc.* **185**, 1 (1978).
6. Claverie, A., Isaak, G.R., McLeod, C.P., van der Raay, H.B. & Roca Cortes, T. *Nature* **282**, 591 (1979).
7. Iben, I. & Mahaffy, J. *Astrophys. J.* **209**, 39 (1976).
8. Christensen-Dalsgaard, J., Gough, D.O. & Morgan, J.G. *Astr. Astrophys* **73**, 121 (1979).
9. Claverie, A., Isaak, G.R., McLeod, C.P., van der Raay, H.B. & Roca Cortes, T. *XIV Eslab Symposium* (1980).
10. Brookes, J.R., Isaak, G.R. & van der Raay, H.B. *XIV Eslab Symposium* (1980).

Coronavirus come of age

from B.W.J. Mahy

ALMOST thirty years after the pioneering work of A.W. Gledhill and C.H. Andrewes at the Mill Hill laboratories established the essential features of murine hepatitis virus (MHV) infection (*Brit. J. exp. Pathol.* **32**, 559) the first international conference on the coronavirus group, of which MHV is the best studied member, has been held in Germany*. The meeting consolidated much new and interesting data on a group of viruses responsible for a wide range of acute and chronic diseases. These presently include respiratory and enteric disease in humans, bronchitis in birds, transmissible gastroenteritis and encephalitis in pigs, diarrhoea in calves and dogs, peritonitis in cats, and both demyelinating encephalitis and hepatitis in rodents. A recent report of the isolation of coronaviruses from the brains of multiple sclerosis patients (Burks *et al. Science* **209**, 933; 1980) has intensified interest in the group.

During the first half of the meeting, on structure and replication, it became clear that, in addition to the characteristic morphological features of the group, coronaviruses from whatever species are unified by the possession of a large infectious single-stranded genome of 6 to 7×10^6 molecular weight. Both the mechanism of expression of this genome, and the protein products, have unique features. M.C. Lai (Los Angeles) for a murine coronavirus and S.I.T. Kennedy (La Jolla) working with avian infectious bronchitis, each presented evidence that the genome is positive-stranded, with a capped (m^7G) 5′-terminus and a stretch of poly(A) at the 3′-terminus. In infected cells six virus-specific RNA species are consistently found, ranging in molecular weight from 0.6×10^6 up to genome size. T_1 ribonuclease mapping studies (S.I.T. Kennedy and J.L. Leibowitz, La Jolla) show that these RNAs form a 'nested set', the sequence of each RNA being contained

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