the magnesio–hornblende type. Spinel is an aluminium-rich Fe–Mg type and its chemistry is comparable with that of the spinels of the ultramafic rocks from the Sargur area[2].

Various geothermometers[3-5] are employed to determine the temperature conditions of metamorphism using the miscibility data of coexisting ortho- and clinopyroxenes. Temperature calculation using the model of Wells[4] for the pyroxene pairs from an ultramafic rock of the Terakanambi area yielded 690°C (corrected for −60°, cf. Raith *et al*[6]). However, the temperature estimate based on Powell's geothermometer[5] is higher (764°C/7 kb) than that obtained from the Wells model. The present temperature estimate of 690°C for the ultramafic rocks is consistent with the reported temperature of 700±20°C for the ortho- and clinopyroxene pairs from the ultramafic rocks of the Sargur area[2]. The estimated metamorphic temperature of 690°C for the ultramafic rocks of the Terakanambi area clearly indicates imprints of upper amphibolite facies metamorphism.

The authors thank Prof. C. Naganna and Prof. A. S. Janardhan for encouragement. BMR thanks UGC, New Delhi, for financial assistance.

2 August 1988; Revised 21 September 1988

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A NOTE ON THE CRYSTALLIZATION OF FOOT-AND-MOUTH-DISEASE VIRUS

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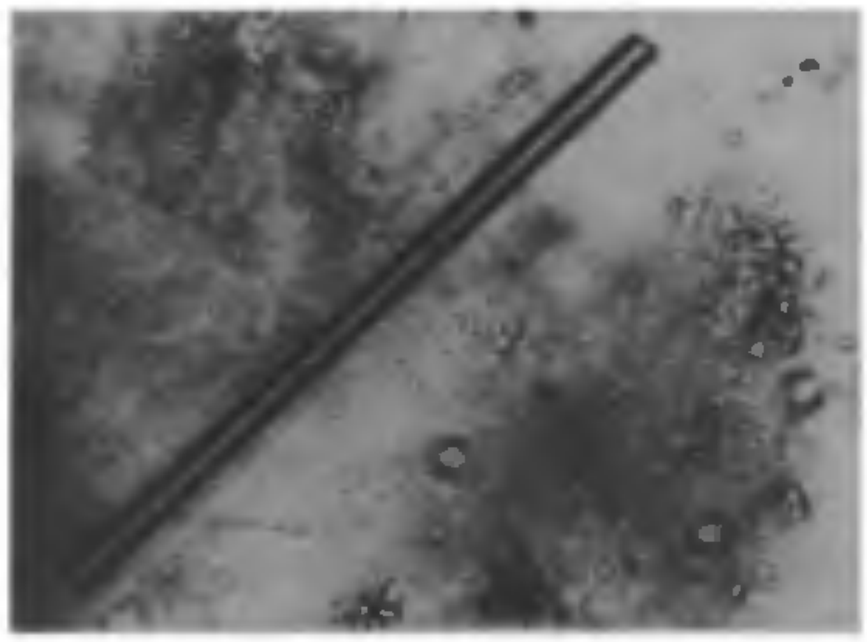
ANIMAL viruses, regarded as biological macromolecular assemblies, have kindled provocative pursuits in different scientific disciplines. A significant lead is to examine the possibility of these viruses forming crystals and to study the conformation of the immunogenic sites in their proteins and glycoproteins.

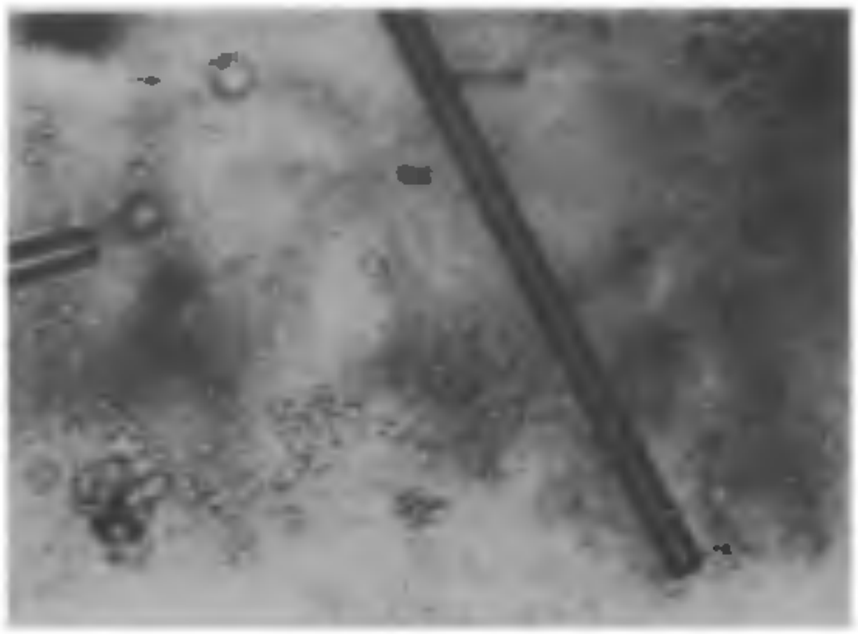
Foot-and-mouth-disease virus is a member of the genus *Apthovirus* in the family Picornaviridae[1]. It is icosahedral with an approximate diameter[2] of 300° A, and contains a single, unsegmented strand of positive-sense RNA (M_r 2.6×10^6), 60 copies of each of the four polypeptides designated VP_1, VP_2, VP_3 and VP_4, and one to two copies of VP_2 and VP_4 present as an uncleaved precursor molecule, VP_0. Crystalline virus structures have been described for representatives of three of four genera of Picornaviridae, namely human rhinovirus[3] 14, poliovirus[4] and mengovirus[5]. These show a startling similarity in both tertiary and quaternary structures. We report in this communication our preliminary effort to crystallize foot-and-mouth-disease virus serotypes O, A, C and Asia-I.

Foot-and-mouth-disease virus types were grown in BHK_{21} cell monolayers overnight at 37°C and purified in sucrose or cesium chloride density gradients[6, 7]. The recovered virus was concentrated by pelleting through 30% sucrose containing a mixture of 10 mM sodium phosphate (pH 7.6) and 150 mM sodium chloride (pH 7.6) at 200,000 *g* for 3 h. Pellets were resuspended in 50 mM potassium phosphate buffer (pH 7.6) containing 100 mM ammonium sulphate and a trace of NaN_3 to obtain a virus concentration of 10–15 mg/ml. Any debris was removed in a microcentrifuge. Uninfected BHK_{21} cells were subjected to the same procedure and used as control. The crystallization set-ups of siliconized glass haemagglutination wells, were placed inside sealed petri dishes that were saturated with 50 mM potassium phosphate (pH 7.6) containing 100 mM ammonium sulphate and 1% PEG (PEG 4000, Sigma) and used for vapour diffusion. Crystals formed when 10 µl of purified virus (10 µg/µl) and 10µl of 50 mM potassium phosphate buffer (pH 7.8) containing 100 mM ammonium sulphate and 1% PEG were allowed to reach equilibrium at room temperature (24 C) for 15 to 21 days. No crystals developed in the control preparations. The virus crystals formed disintegrated when repeatedly forced through a glass capillary tube, a characteristic feature of crystals of biological macromolecules. The crystals were washed thrice with 50 mM potassium phosphate buffer (pH 7.8) containing 100 mM ammonium sulphate and then dissolved in cold 50 mM

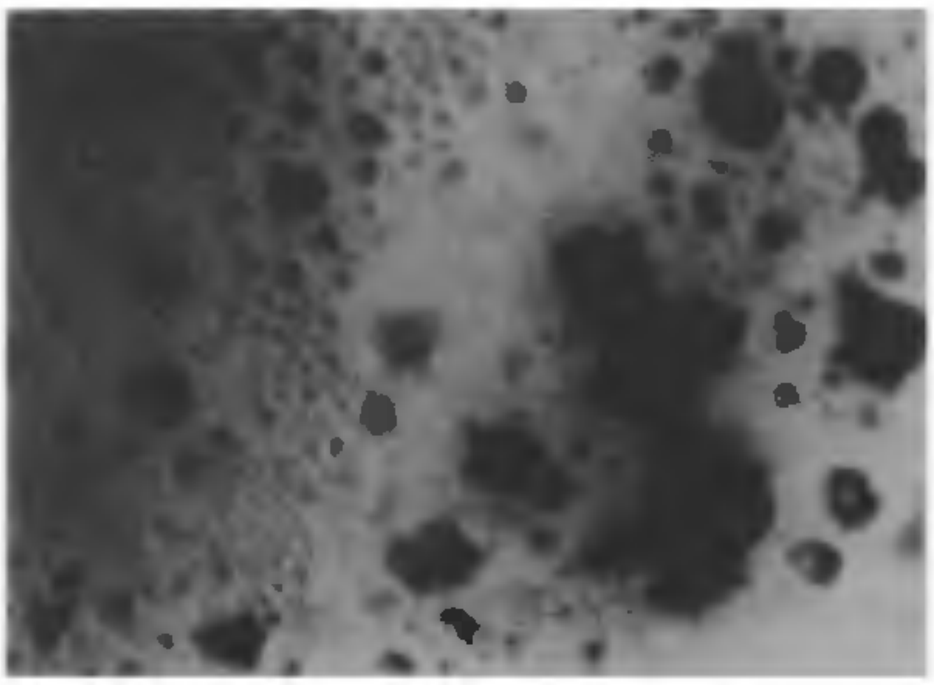
Type: O



Type: A



Type: C



Type: Asia-I

Figure 1. Foot-and-mouth-disease virus crystals.

potassium phosphate buffer (pH 7.8) before use in tests such as PAGE and ELISA. Infectivity of the crystals was established by inoculation into BHK_{21} cell cultures.

As depicted in the figure, crystals of the different virus serotypes had different morphologies. Type O crystals were hexagonal bipyramids 0.03 mm long and 0.02 mm in diameter. Crystals of types A and C were elongated needles measuring 0.21 mm in length and 0.24 mm across. Type Asia I crystals were rectangular and square plates of 0.03 mm size. When mounted for X-ray diffraction, the crystals seemed to be destabilized by X-rays. Further work is in progress.

5 July 1988; Revised 7 September 1988

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CHAROPHYTA FROM NINIYUR FORMATION, ARIYALUR, TAMIL NADU

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THE biohermal limestones of Niniyur Formation, Ariyalur area, are known to contain algae, foramini-