Phyllocarid Crustacean Fauna of European Aspect from the Devonian of Western Australia

A REMARKABLE collection of about 400 specimens of phyllocarid crustaceans was made in 1963 by H. A. Toombs of the British Museum (Natural History), and K. Buller and E. Car of the Western Australian Museum. The material was collected at two localities from calcareous siltstone concretions in the Gogo Formation which yields a lower *Manticoceras* Zone (*Timanites angustus* Subzone) goniatite fauna of Frasnian 1α age, Upper Devonian[1-3]. The localities are: 1, Virgin Bore area, Gogo Station, 125° 54′ E., 18° 35′ S., and 2, Bugle Gap, 126° 02′ 15″ E., 18° 41′ S., both in the Fitzroy Basin, Kimberley Division of Western Australia. Preliminary identifications of the phyllocarids, together with the relative frequency of occurrence, are as follows:

Locality 1: *Montecaris lehmanni* Jux, abundant; *Montecaris sp. nov.* ?, a very rare, heavily tuberculate form; *Concavicaris sp. nov.* 1 *aff. C. elytroides* (Meek), rare; *Schugurocaris sp.*, rare.

Locality 2: *Concavicaris spp. nov.* 1 *and* 2, *Schugurocaris sp*.

The fauna of the Gogo Formation is stated to be "characterized by *Buchiola* and other pelecypods, numerous *Tentaculites*, small, straight nautiloids, ostracods and coccostean and crustacean remains, [the ammonoids] *Timanites* and *Koenenites*"[2]. The ammonoids and Foraminifera have recently been described, and Radiolaria and conodonts are also known to occur[3,4]. In addition to most of the foregoing, however, the locality 1 fauna in the present collection includes bryozoans, gastropods, a single specimen of a eurypterid best referred to *Rhenopterus* (determined by Dr. C. D. Waterston), and the following fish (determined by H. A. Toombs): antiarchs and arthrodires (under study by Dr. R. S. Miles), palaeoniscids (to be studied by Dr. B. Gardiner) and rhipidistians, as well as coprolites and problematica.

The phyllocarid fauna is important not only in being a unique association of genera, but also in being of European aspect. Thus *M. lehmanni* is otherwise known only from the Frasnian 1α of the Rhenish Schiefergebirge[5]. *Montecaris* is recorded from the Gedinnian and Famennian of Czechoslovakia, the Lower Frasnian of the Transvolga region of the U.S.S.R. (? = *Baituganocaris* Krestnovnikov) and possibly from the Upper Devonian of British Columbia[6]. *Eleutherocaris*, the other member of the Montecaridinae, is known only from the Frasnian Naples fauna of New York State, U.S.A. *Schugurocaris* (? = *Phasganocaris*) was described from the Lower Frasnian of the Transvolga/Urals[7], although it may occur in the Ludlovian of British Columbia and the Gedinnian and ?Emsian of Czechoslovakia[8]. *Concavicaris elytroides* occurs in the Famennian–Lower Mississippian of Oklahoma and Kentucky, but the genus ranges from Eifelian to Pennsylvanian of Czechoslovakia and the U.S.A.

The overwhelmingly European character of the Western Australian Devonian has been stressed by Teichert[9,10], and is apparent even in this small phyllocarid fauna. North American affinities are also indicated by the closely related genera and species mentioned here, but this is probably due to the derivation of both Australian and American faunas from common European stocks. Close affinity between the American and European ammonoid faunas is most clearly developed in the Frasnian[11]. Teichert's theory that the Australian faunas migrated from central Germany via south-east Asia has been criticized by Neaverson[12] but reaffirmed by Veevers[13].

The Australian and European phyllocarids mentioned here occur in platy, silty limestones or calcareous siltstones deposited in still waters in inter-reef basins[14,16]. Sedimentation was fine grained and continuous, and benthos was thereby inhibited. A platy sedimentary breccia, similar to those in the Schiefergebirge[15], has been collected from locality 2 and suggests that similar off-reef slumping took place.

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W. D. IAN ROLFE

Hunterian Museum,
University of Glasgow.

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METALLURGY

Enhancement of Ductility in α-Uranium

CIRCUMSTANCES have been identified where metals and alloys undergo large plastic extensions, that is, 100–1,000 per cent elongation, before rupture[1,2]. Such materials are termed[2] 'superplastic' and can be extremely sensitive to changes in strain-rate[3], thus having a high value of the exponent, n, in the relationship between strain-rate $\dot{\varepsilon}$ and stress σ described by $\dot{\varepsilon}^n = k\sigma$, where k is a constant. Generally, n has values < 0.3 in conventional tensile or creep tests even at temperatures approaching the melting-point; but certain non-ferrous alloys[3], notably those near eutectoid composition in the aluminium–zinc system which extend by several times their original length, have values of n up to ~ 0.7.

Where n approaches unity, deformation tends to viscous (Newtonian) flow and, in this event, large elongations are possible since there is no enhancement of the rate of diminution of cross-sectional area. A common circumstance where metals deform by viscous flow is where vacancy creep[4] occurs, but a rapid rate of straining is generally impossible even at temperatures close to the melting-point since stresses must be sufficiently small to prevent dislocation movement.

One method of making polycrystalline uranium of random orientation flow viscously at temperatures away from the melting temperature, for example, $< 450°$ C, is to irradiate it with neutrons[5]. Under stresses about $Y/100$ and irradiation at 100° C, α-uranium exhibits a steady-state creep rate of $\sim 10^{-7}$ h^{-1} and approximately obeys a pseudo-creep law of the form, $\dot{\varepsilon} \simeq (\sigma/Y)\dot{\varepsilon}_g$, where Y is the yield strength of the material and $\dot{\varepsilon}_g$ the irradiation growth rate of individual crystals. This equation corresponds to a strain-rate exponent of unity and has been demonstrated experimentally by Roberts and Cottrell[6], who used small springs of uranium wire to facilitate measurement of the slow creep-rate. A demonstration of large elongations with tensile forces in these circumstances would not be practical despite the closeness of n to unity. (Calculations based on their results give $n \sim 0.8$ using low-deflexion formulae to deduce the appropriate stresses and strain-rates.)

It is demonstrated here that viscous flow can be induced in lightly stressed materials with anisotropic coefficients of thermal expansion, by subjecting them to temperature changes sufficient to create 'spontaneous plasticity'[6]. It is expected, therefore, that under tensile forces and