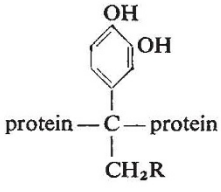
others, who have studied the hardening of the blowfly puparium, the immediate precursor of the tanning agent is acetyldopamine derived from tyrosine by way of dopa and dopamine; and it is generally believed that it is the quinone formed by the oxidation of acetyldopamine which tans the protein.

This is a violent and irreversible reaction in which the protein chains are believed to be bound directly to the benzene ring to give a hard and deeply pigmented product. But it has long been suspected that other forms of polymerization probably occur and give rise to sclerotin of a paler and softer kind. It is therefore very interesting that S. O. Andersen and F. M. Barrett (*J. Insect Physiol.*, **17**, 69; 1971) should have been able to obtain direct evidence for the existence of compounds of this sort. They have shown that several catechol derivatives can be isolated from acid hydrolysates of the hard cuticle of the locust *Schistocerca* and other insects. The two major components are a hydroxy-ketocatechol (2-hydroxy-3′,4′-dihydroxy-acetophenone) and the corresponding aldehyde 3,4-dihydroxyphenylglyoxal.

The ketocatechols cannot be obtained from locust cuticle in the newly moulted insect. During hardening, when the proteins in both endocuticle and exocuticle are rendered insoluble, the amount of acid-released ketocatechols increases up to 3 per cent of the cuticle dry weight. The keto group, as judged from the ultraviolet spectrum, becomes released only during hydrolysis —from which it is inferred that the proteins are linked to the β-carbon atom of the aliphatic side chain of the catechol. Thus:



If R is $-NHCOCH_3$, this structure on hydrolysis will give arterenone, and if R is $-OH$ neutral ketocatechol will be obtained. Both products have been found.

This mechanism does not, of course, rule out the involvement of quinones also in cuticle sclerotization; these two processes can well take place simultaneously—quinone tanning perhaps for mass production; ketocatechol polymerization for more controlled and less violent sclerotization. Ketocatechols have so far been obtained from all insect species investigated but not from any other arthropods. Still further mechanisms for hardening may well exist.

MUSCLE

Where's the Myosin?

from our Cell Biology Correspondent

THE enormous progress which has been made during the past two decades in our understanding of the structure and functioning of striated muscle is an object lesson to all cell biologists seriously determined to understand the molecular architecture of cells. So much is known about how muscle is organized and functions because electron microscopic observations have been combined and correlated with X-ray diffraction studies; data obtained by one technique have not only lent credence to that obtained by the other but also each approach has complemented the other, filling in the gaps inevitable when only one method is used alone. Of course, the structure of striated muscle is ideally suited to analysis by these two techniques and when it comes to analysing in the same way other biological structures of greater biochemical complexity and less regular and rigid architecture we can expect the going to be far tougher. For example, the molecular architecture of even smooth muscle, the biochemistry of which, not surprisingly, is basically similar to that of striated muscle, is proving decidedly more difficult to sort out.

Like striated muscle, vertebrate smooth muscle contains the three proteins actin, myosin and tropomyosin but the crucial —and unsolved—question as far as models of contraction are concerned is how these proteins are aggregated. Electron microscopy of sections of smooth muscle fixed and embedded by the procedures now conventional for striated muscle reveals thin actin filaments but does not reveal corresponding thick filaments characteristic of myosin aggregates. It is becoming increasingly clear, however, that thick, presumably myosin, filaments can be seen in smooth muscle which has been subjected to various manipulations. Last year, for example, Rice *et al.* (*J. Cell Biol.*, **47**, 183; 1970) reported observing thin actin and thick myosin filaments in contracted taenia coli muscle fixed in hypertonic

A Liquid Phase in Polycrystalline Ice

THE first evidence for the existence of a liquid phase in polycrystalline ice came to light about three years ago (for example, *Chem. Comm.*, **17**, 323 and 880; 1967), and in next Monday's *Nature Physical Science* the topic is further examined in some depth and from different points of view.

Several explanations of the rather unexpected liquid phase have been put forward, including the postulate of a thin surface liquid film and of a surface energy at grain corners which causes local freezing point depression; impurities and interstitial water molecules have also been thought responsible by several workers. Bell *et al.* describe their proton magnetic resonance (PMR) measurements on ice prepared under a number of conditions but feel unable to commit themselves to any of the available theories.

Paren and Walker, however, favour the explanation based on the limited solubility of inorganic compounds in ice; this phenomenon arises because few inorganic compounds are capable of incorporating themselves to any great extent into the ice structure. They are either unable to form the necessary hydrogen bonds with the water molecules or they are the wrong size or both. As a consequence, liquid inevitably forms within ice if the concentration is above the very small solubility limit (a mol fraction of about 10^{-7} or less for the salts in seawater, for example). Even very carefully prepared water samples, deposited from the vapour phase into a clean quartz sample tube and then frozen, gave a PMR signal corresponding to about 0.1 per cent of liquid within the ice.

It has been suggested that the liquid is in the form of intergranular fillets and Paren and Walker support this hypothesis although they admit that intragranular inclusions are also a possibility. They point out that at very high impurity concentrations, the total electrical conduction near the melting point is dominated by the brine veins, but that at impurity concentrations nearer the solubility limit more and more of the conduction can be ascribed to the solid solution. Paren and Walker have been able to deduce from electrical evidence that the solubility limit for sea salts is about 4×10^{-8} mol fraction.

As far as mechanical properties are concerned, a fairly simple relationship between creep rate and applied stress seems to hold for polycrystalline ice between $-50°$ C and $-10°$ C, but at higher temperatures the rate is greater than would be expected. Single crystals of ice, however, behave predictably up to 0° C, and Paren and Walker suggest that the liquid phase softens ice polycrystals when the solubility limit is exceeded. The implications for glaciology are obviously important, and although veins have been suggested previously as a means of draining off soluble and gaseous impurities from temperate glaciers it now seems possible that a similar mechanism is also at work in colder glaciers.