species which lay relatively few, large-yolked eggs, which is not unexpected in view of the high mortalities normal in the marine plankton.

Galaxias maculatus is also seen to be the most widely distributed, being found in southern Australia, and the southern tip of South America, as well as New Zealand. This in itself is not surprising in view of its spawning habits which would assist dispersal by ocean currents. From this and the evidence of the distribution of the other galaxiid species in Australia and New Zealand, McDowall suggests that they evolved in the Australasian region, and that their establishment elsewhere has been by trans-oceanic dispersal. Confirmation of this may depend on systematic studies of the Australian and South American galaxiid faunas both of which are very imperfectly known.

MYOSIN

What the Early Burst Catches

from our Molecular Biology Correspondent

It can be argued that any attempt to define the nature of the myosin-actin interaction, which lies at the heart of the mechanism of muscular contraction, would be otiose without a prior analysis of the myosin ATPase reaction. Two papers from Taylor's laboratory in Chicago go a long way towards dispelling the fog into which a mass of scattered and undigested data had plunged the enzymology of myosin. The key to the ATPase mechanism lies in the old observation that the course of steady-state hydrolysis extrapolates at zero time to a finite value for the number of protons released. This is the so-called "early burst" phenomenon, and its origin has been a matter of conjecture. Lymn and Taylor (*Biochemistry*, **9**, 2975; 1970) have now studied the kinetics of the early burst, which occurs within a time-scale of the order of 0.1 s. Their method consists in arresting the reaction at chosen times by rapid introduction of acid, and then determining the total phosphate released from labelled ATP within the total reaction time. The kinetics, especially at relatively low ATP concentrations, adhere closely to a single-term rate equation. The magnitude of the total burst is a function of ATP concentration, and extrapolates to a maximum of 1.8 moles of phosphate released per mole of myosin—that is to say essentially one for each active site. One of the most striking features of the reaction is that the early burst occurs, and with the same kinetic characteristics, both in the presence of calcium and of magnesium, even though the latter strongly inhibits the ATPase, as normally measured in the steady state. In the presence of EDTA, which activates the ATPase, the early burst is completely eliminated, and instead a lag phase of some 0.1 s precedes the attainment of the steady-state rate. Now this pattern is characteristic of the simplest model for an enzymic reaction, whereby an enzyme-substrate complex is first formed in a concentration governed by a single binding constant, and then decomposes to enzyme and products by a first-order process. The lag is a consequence of the accumulation of complex, and the Michaelis constant can be derived from measurements of the lag as a function of substrate concentration. The value thus obtained for myosin agrees with that derived in conventional manner from steady-state velocities.

With calcium or magnesium, on the other hand, the relation between rate in the transient phase and the size of the burst is entirely consistent with the presence of a second reaction intermediate, in the form of an enzyme-product complex. The lag phase is not here observed because of the rapidity with which the enzyme-substrate complex is converted to the enzyme-product complex. Once the latter has been formed, with release of a proton for each active site, it is its dissociation that becomes rate-limiting. It is at this point in the scheme that the behaviour of calcium and magnesium ions differs, and at which also actin must be presumed to mediate the reaction.

In the accompanying paper, Taylor, Lymn and Moll (*ibid.*, 2984) enlarge on the properties of the enzyme-product complex. Their experiments are based on the exclusion of myosin, and not of ATP or free products from the matrix of a gel-filtration column. A zone of ATP is run into the top of the column and a band of myosin is then rapidly passed through. The extent to which the two reaction products, ^{32}P -labelled phosphate and tritiated ADP, cleave to the myosin can be determined as a function of time by comparing the radioactivity elution profiles with that of the protein. Under standard conditions, in the presence of magnesium, it turns out that both ADP and phosphate are bound, and their rate of dissociation from the myosin is in gratifying agreement with the steady-state rate of magnesium-inhibited ATP hydrolysis. In the presence of calcium, the dissociation rate is, as expected, too fast to measure. These critical experiments leave little doubt that it is indeed the dissociation of the products, in particular the ADP, that governs the hydrolysis rate, and this simple mechanism makes redundant earlier and more complex schemes. There is some evidence from non-linearity of binding plots which raises again the possibility that the ATPase sites on the two myosin heads may not be completely independent.

An investigation of myosin by attachment of a spin-label to the thiol groups comes from Saidel, Chopek and Gergely (*ibid.*, 3265). The broadening of the ESR signals from the label shows that its mobility becomes severely restricted on binding. Addition of ATP or pyrophosphate leads to an increase in the mobility, the effect becoming maximal at a ratio of two moles pyrophosphate per mole of myosin. The label must be supposed to respond to some small localized structural change. It is interesting that the effect of ATP persists even after inactivation of ATPase activity by chemical modification.

VIRUSES

Going it Alone

from our Cell Biology Correspondent

THE twin concepts of defective viruses and helper viruses have played an important part in the development of RNA tumour virus biology. Increasingly, however, it is becoming obvious that the supposed defectiveness of many RNA tumour viruses is an artefact of the way they are studied and ignorance of the factors which determine the host range of particular viruses. For example, Bryan high titre Rous sarcoma virus was for many years described as defective because its envelope had to be supplied by an avian