425; 1970). Both syntheses construct the four-membered ring by the photochemical addition of ethylene to a cyclic olefin; the former group choosing 3-methylcyclohexenone (V) and the latter group using a dehydration product of mevalonolactone, 3-methylpent-2-enolactone (VI). This photoaddition guarantees the correct *cis*-stereochemistry for the ultimate product (I) which is obtained in 10 per cent overall yield after further chemical transformations to give the correct side chains.

Without this component, mixtures of the other three synthetic compounds fail to attract boll weevils whereas the attracting power of the combination of all four chemicals in the correct proportions closely matches that of the natural pheromone. This research may not only provide a solution to the control of the boll weevil, but also assist in restricted distribution of insecticides.

AMPHIBIA

Ancestors of the Reptiles

from our Vertebrate Palaeontology Correspondent

THE vexed question of the amphibian ancestry of the reptiles has been aired again. According to R. L. Carroll, the carboniferous tetrapod, *Gephyrostegus*, although too recent to be the ancestor in question, seems to have the characteristics required for such an evolutionary position (*Phil. Trans. Roy. Soc.*, B, **257**, 267; 1970).

The most important criterion distinguishing living reptiles from amphibians is their mode of development. Reptiles (and birds) usually lay an egg which provides all the material needs of the developing embryo so that it may hatch fully formed. This amniote egg has not developed in amphibia and a protracted larval stage is common, although many species have curtailed or even eliminated this vulnerable stage in their development by other means. When dealing with the fossil remains of early tetrapods it is thus very difficult to establish criteria for deciding whether a given "reptiliomorph" tetrapod is to be classified as a reptile or an amphibian.

Many years ago, the fossil tetrapods, thought to be the most primitive reptiles, were placed in three groups by D. M. S. Watson: the first represented by *Seymouria*, the second by *Diadectes* and the third by *Captorhinus*. All three "type" genera were from early Permian deposits from Texas and surrounding states. For many years the status of *Seymouria* was disputed: was it a reptile or an amphibian? On the one hand, it was a sturdy terrestrial form with many characters regarded as reptilian; and on the other hand, the structure of the middle ear region, critical to the interpretation of early tetrapods, favoured amphibian affinity. The matter was finally settled when Špinar in Prague demonstrated that closely related forms from the European Lower Permian developed external gills during their development and thus had a larval stage.

Thus *Seymouria* was an amphibian, but it was still accorded an honoured place as a relict reptilian ancestor. It was recognized, however, that while it was probably closely related to *Diadectes*, a massive form with an enormous otic notch to hold the eardrum, it was not particularly closely related to *Captorhinus* and its allies, small lizard-like forms with no otic notch, and with an eardrum that must have been situated behind the skull. Unfortunately for the status of *Seymouria* it is *Captorhinus*, or rather its less specialized predecessors, which are probably the most closely related to the ancestry of all subsequent reptiles.

These primitive captorhinomorphs occur very much earlier in the fossil record than either *Captorhinus* or *Seymouria*. The earliest known comes from a horizon in Nova Scotia which is early Pennsylvanian and probably equivalent to the Middle Coal Measures of Britain. This and another somewhat later and better preserved form (*Paleothyris*) have been described by Carroll, of the Redpath Museum, McGill University, as part of a general attack on the problem of reptile origins. He has also undertaken a detailed anatomical study of several little known and difficult fossils from Carboniferous horizons in Europe more recent than the British Coal Measures. Most important of these is the genus from Nýřany in Bohemia, but there are other specimens of disputed affinity which he considers the descendants of early offshoots of the amphibian–reptilian evolutionary stock.

Last year (*Biol. Rev.*, **44**, 393; 1969) Carroll characterized *Gephyrostegus* as an ideal relict of the reptilian ancestor, although, like *Seymouria*, too late in time to occupy a true ancestral position. However, it lacks some of the aberrant specializations of the ear region which *Seymouria* has. Carroll attempted to demonstrate by a close comparison of the whole skeletons of *Gephyrostegus* and *Paleothyris* the stages in the evolution of a reptilian skeleton from an amphibian skeleton.

His latest contribution has been to describe the anatomy of *Gephyrostegus* and other forms from Nýřany as well as an allied form from a roughly contemporary horizon in the United States. This work is likely to establish *Gephyrostegus* as demonstrating the anatomy of the reptile ancestor, but a lingering doubt remains. While *Gephyrostegus* lacks the specializations of *Seymouria* its skull is still basically similar and in critical features of the back of the skull roof and occiput thus resembles *Diadectes* rather than the certainly reptilian captorhinomorphs. Meanwhile, *Diadectes* has come to be considered by many as a sterile end form of an evolutionary line quite separate from true reptiles.

EVOLUTION

Ammonites indicate Reversal

from a Correspondent

CAN the course of evolution turn back on itself? Or does some sort of momentum keep an organism proceeding in a particular evolutionary direction, even if this results in the production of aberrant and non-adaptive types, forming an evolutionary cul-de-sac ending in extinction? Among evidence often cited for the latter point of view is the production of aberrant forms by the familiar spiral-shelled ammonites, of which fossil remains are found from the early Devonian through to the Cretaceous. In these aberrant forms, called heteromorphs, either the whole shell, or part of it, is unrolled. This is interpreted as a sign of overspecialization or racial senility, preceding inevitable extinction.

A drawback of this point of view is that it effectively credits evolution with an intrinsic rhythm, comparable with that of an individual life, with each type having a