Passage 3 The history of the tortoise

If you go back far enough, everything lived in the sea. At various points （ ） in evolutionary （ ） history, enterprising （ ） individuals within many different animal groups moved out onto the land, sometimes even to the most parched （ ） deserts （ ）, taking their own private seawater with them in blood and cellular fluids （ ）. In addition to the reptiles （ ）, birds, mammals （ ） and insects which we see all around us, other groups that have succeeded out of water include scorpions （ ）, snails （ ）, crustaceans （ ） such as woodlice （ ） and land crabs （ ）, millipedes （ ） and centipedes （ ）, spiders （ ） and various worms （ ）. And we mustn't forget the plants, without whose prior invasion （ ） of the land none of the other migrations （ ） could have happened.

Moving from water to land involved a major redesign of every aspect （ ） of life including breathing （ ） and reproduction （ ）. Nevertheless （ ）, a good number of thoroughgoing land animals later turned around, abandoned their hard-earned terrestrial （ ） re-tooling （ ）, and returned to the water again. Seals （ ） have only gone part way back. They show us what the intermediates （ ） might have been like, on the way to extreme cases such as whales （ ） and dugongs （ ）. Whales (including the small whales we call dolphins)and dugongs, with their close cousins （ ） the manatees （ ）, ceased （ ） to be land creatures altogether and reverted （ ） to the full marine （ ） habits of their remote （ ）ancestors （ ）. They don’t even come ashore （ ） to breed （ ）. They do, however, still breathe air, having never developed anything equivalent （ ） to the gills （ ） of their earlier marine incarnation （ ）. Turtles went back to the sea a very long time ago and, like all vertebrate （ ） returnees to the water, they breathe air. However, they are, in one respect （ ）, less fully given back to the water than whales or dugongs, for turtles still lay （ ） their eggs on beaches.

There is evidence that all modern turtles are descended from （ ） a terrestrial ancestor which lived before most of the dinosaurs （ ）. There are two key fossils called *Proganochelys quenstedti* and *Palaeochersis talampayensis* dating from （ ） early dinosaur times, which appear to be close to the ancestry （ ） of all modern turtles and tortoises. You might wonder （ ） how we can tell whether fossil （ ） animals lived on land or in water, especially if only fragments （ ） are found. Sometimes it's obvious （ ）. Ichthyosaurs were reptilian （ ） contemporaries （ ） of the dinosaurs, with fins （ ） and streamlined （ ） bodies. The fossils look like dolphins and they surely lived like dolphins, in the water. With turtles it is a little less obvious. One way to tell is by measuring the bones of their forelimbs. （ ）

Walter Joyce and Jacques Gauthier, at Yale University, obtained three measurements in

these particular bones of 71 species of living turtles and tortoises. They used a kind of triangular graph paper（ ） to plot（ ） the three measurements against one another. All the land tortoise species formed a tight（ ）cluster（ ） of points in the upper part of the triangle; all the water turtles cluster in the lower part of the triangular graph. There was no overlap （ ）, except when they added some species that spend time both in water and on land. Sure enough, these amphibious（ ） species show up on the triangular graph approximately half way（ ） between the ‘wet cluster' of sea turtles and the ‘dry cluster ‘of land tortoises. The next step was to determine where the fossils fell. The bones of *P.quenstedti* and *P.talampayensis* leave us in no doubt （ ）. Their points on the graph are right in the thick of the dry cluster. Both these fossils were dry-land tortoises. They come from the era （ ） before our turtles returned to the water.

You might think, therefore, that modern land tortoises have probably stayed on land ever since（ ） those early terrestrial times, as most mammals did after a few of them went back to the sea. But apparently（ ） not. If you draw（ ） out the family tree of all modern turtles and tortoises, nearly （ ） all the branches （ ） are aquatic（ ）. Today’s land tortoises constitute（ ） a single branch deeply nested （ ） among branches consisting of aquatic turtles. This suggests that modern land tortoises have not stayed on land continuously （ ） since the time of *P.quenstedti* and *P.talampayensis*. Rather, their ancestors were among those who went back to the water, and they then re-emerged back onto the land in (relatively) more recent times.

Tortoises therefore represent（ ） a remarkable（ ） double return. In common with （ ） all mammals, reptiles and birds, their remote ancestors were marine fish and before that various more or less worm-like creatures stretching back, still in the sea, to the primeval （ ） bacteria. Later ancestors lived on land and stayed there for a very large number of generations Later ancestors still evolved back into the water and became sea turtles. And finally they returned yet again to the land as tortoises, some of which now live in the driest of deserts.