ENGLISH IN FOCUS
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ENGLISH IN FOCUS

English in Biological Science

IAN PEARSON

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7 Evolution

I READING AND COMPREHENSION

THE EVIDENCE FOR EVOLUTION

Almost all biologists believe that over millions of years the characteristics of a species change. The horse, for example, is thought to be the descendant of a long series of horse-like animals. It is also believed that a single ancestral species can give rise to a number of different species. Thus, the horse, the ass, the zebra, and other horse-like animals are thought to derive from a common ancestral species. The name we give to the process of change is evolution, and we say that species evolve.

One source of evidence that species evolve is Comparative Embryology. When we compare the embryos of different vertebrates, we find that there are some obvious similarities. However, if the adult forms are then compared, many of these similarities cannot be found. For example, all vertebrate embryos possess very similar embryonic bones just behind the brain-case. In a fish these bones develop into jaw-bones, whereas in a mammal they develop into ear-bones and function as part of the hearing apparatus. If all vertebrates have a common ancestor, we can begin to explain why the embryos are similar.

Further evidence is provided by Comparative Anatomy. For example, the arm of a man, the wing of a bird, and the front leg of a horse are different in form and function. In each case, there is a clear relationship between what the limb looks like and what it is used for. But when we look at the anatomy of these three limbs, we find that each one is built on exactly the same general pattern. Again, this similarity is difficult to explain unless we accept that all vertebrates have a common ancestor.

Of the other sources of evidence for evolution, the most important is perhaps Palaeontology, which is the study of the fossilized remains of organisms that lived millions of years ago. The fossils of ancient animals and plants show us that these organisms were more or less different from today's organisms. Further, at any one time in the past, the organisms were more or less different from those that came before and those that came after. The obvious explanation for such differences is that organisms evolve. However, the process of change must be extremely slow, because even quite small changes apparently take place over millions of years. If this is true, it explains why it is so difficult for us to observe the process of evolution as it proceeds in living organisms.

EXERCISE A Finding out about the meaning of words

Find in the passage the words and phrases given below and see if you can answer the questions about them. The numbers in brackets refer to the paragraphs in which the words occur.

1. give rise to (1) here means the same as evolve into. Which phrase in the same paragraph here means evolve from?
2. If I tell you 'I believe that species evolve' I want to make it clear that I accept the idea as true, but I also show you that I cannot prove that the idea is true. Which other verb in the first paragraph gives the same information as believe?
3. evidence (2) here means support for a belief. A source of evidence is:
   (a) one type of evidence
   (b) where we find evidence
   (c) a large amount of evidence
4. obvious similarities (2) refers here to ones which are easy to:
   (a) see
   (b) describe
   (c) understand
5. further evidence (3) has a similar meaning to:
   (a) stronger evidence
   (b) additional evidence
   (c) more recent evidence
6. Which word is used in paragraph 3 to include the wing of a bird and the arm of a man?
7. fossilized remains (4) are found in very ancient rocks. Do you think fossilized means:
   (a) bone-like
   (b) extremely hard
   (c) turned to stone
8. Further (4) does not mean the same thing here as it does in the third paragraph. Do you think it could be replaced here by:
   (a) In addition
   (b) Similarly
   (c) Therefore
9. Living organisms (4) do not contrast with dead organisms. We say that live organisms ‘die’ and are then ‘dead’. But we say that living organisms ‘die out’ and are then ‘extinct’. So, individual organisms die and a species can become extinct. Do you think an extinct species is the same thing as a species that:
   (a) is evolving
   (b) is very rare
   (c) no longer exists

EXERCISE B  Distinguishing facts and beliefs

When we read it is very important to notice whether statements are given as facts or only as reports of what people believe. Study the statements below and try to decide which ones are reports of what some people believe.

Write down all the statements from the list below that you decide are beliefs rather than facts. Begin each with one of the following phrases:

It is thought that . . .
Many people believe that . . .
It is believed that . . .

1. The modern horse is different in some ways from its ancestors.
2. The horse and the zebra have a common ancestor.
3. The embryos of different vertebrates show certain obvious similarities.
4. The hearing apparatus of a mammal includes a number of ear-bones.
5. All vertebrates have a common ancestor.
6. There is fossil evidence for evolution.
7. Changes occur during the process of descent.
8. Evolutionary changes are extremely slow.
9. Some of the differences between living and extinct organisms are very large.

EXERCISE C  Assessing the truth of statements

Sometimes a writer tells us that something is true and sometimes he writes about something in such a way that we can conclude that it is true.

Look at the statements below and note whether you think each one does or does not follow from what is said in the passage. Write the numbers 1–7 in your notebook, followed in each case by does follow or does not follow.

1. Some biologists do not believe that organisms evolve.
2. All vertebrate embryos have a brain-case.
3. An adult fish has no hearing apparatus.
4. There is a greater resemblance between a fish embryo and a mammal embryo than between an adult fish and an adult mammal.

5. The number of bones in the arm of a man is exactly the same as in the front leg of a horse.
6. Palaeontologists are not interested in living organisms.
7. There is no possibility of us seeing the evolutionary process in action.

II USE OF LANGUAGE

EXERCISE D  Describing the bones of the forelimb of a tetrapod

The Tetrapoda are the ‘four-footed’ vertebrates: amphibians, reptiles, birds and mammals. In all cases the limbs are built on the same pattern, although the range of form and function varies widely. The forelimb of Sphenodon (the tuatara lizard of New Zealand) shows us the basic arrangement:

![Figure 7.1 The forelimb of Sphenodon](image)

A complete description of the tetrapod forelimb must cover:

(a) the main parts and their names
(b) the bones making up each part, and their names
(c) the shape and relative sizes of the bones
(d) the way the various bones interrelate

In our description, it is useful to distinguish between the proximal end of a bone or part (i.e. the end nearest the centre of the body) and the distal end.

Now see if you can use the information in Figure 7.1 to complete the statements on the next page. Notice that it is the basic tetrapod forelimb that is described, not the forelimb of Sphenodon as such.
1. The tetrapod forelimb consists of... parts: the upper... and the...
2. The hand is made up of... sets of bones: the carpals... that make up the five digits.
3. The single bone of the... forelimb is called the...
4. ... are called the radius and the...
5. The small... which make up the carpus are called...
6. The five cylindrical bones which make up...
7. The five sets of small cylindrical bones which...
8. The humerus is a large elongated bone which articulates proximally with the pectoral girdle and... with the radius and the...
9. The radius and... are large... bones which articulate... with... and...
10. The carpals are small bones which articulate...
11. The five metacarpals are relatively small cylindrical bones which articulate...
12. The five sets of... consist of small cylindrical bones which articulate...

**EXERCISE E  Describing the length of bones**

Look at Figure 7.2 on the next page, which shows the bones of the forelimb in seven different tetrapods.

**PART ONE**

If a bone is longer than it is wide, we call it a long bone. Complete this statement:

1. The bones of the... are small and roughly rounded in shape, but all the other bones of the forelimb are...

Some long bones are longer than others in the same limb. We can therefore state, for example:

In the horse, the humerus is shorter than the fused radius and ulna.

Now compare the following, using comparative statements similar to the example:

2. the radius and ulna of the cow
3. the humerus and the bones of the lower forelimb of the frog
4. the radius and ulna and the humerus of the bat
5. the second and third metacarpals of the forelimb of the bat
6. the proximal and the two distal phalanges of the third and only digit of the forelimb of the horse (note that we talk of one phalanx)
7. the proximal phalanx of the fourth and of the fifth digits of the forelimb of the bat

*FIGURE 7.2  The bones of the forelimb in seven different tetrapods*
PART TWO

We can also describe bone length by reference to other animals. For example:

The humerus of the horse is relatively shorter than that of the frog.

We must say relatively shorter, because in absolute terms the horse's leg is obviously many times longer than that of the frog. Now compare the following, using statements similar to the example:

1. the humerus of the horse and of the cow
2. the ulna of man and of the frog
3. the radius and ulna of man and of the bat
4. the metacarpals of the bat and of the bird
5. the metacarpals of man and of the bird
6. the radius of the cow and of the frog

EXERCISE F  Describing the fusion, reduction and loss of bones

*Spheno*don (Figure 7.1) probably shows us what the basic ancestral tetrapod limb looked like, so that the various limb-types shown in Figure 7.2 are the result of evolutionary processes. We can therefore describe these limbs by comparing them with the ancestral pattern as represented by *Spheno*don. For example:

(a) In the horse the radius and the ulna are completely fused.
(b) The first and fifth metacarpals of the horse are lost, and the second and fourth are reduced and fused to the third.
(c) Only the third digit is retained in the forelimb of the horse.

In all three of these sentences we see that it is not necessary to mention the ancestral pattern.

Now describe the following:

1. the loss of some metacarpals in the bird
2. the loss of some metacarpals and the fusion of the remaining ones in the cow
3. the fusion of the ulna and the radius of the cow
4. the fusion of the carpals of the bat
5. the fusion of the second and third metacarpals of the bird to some of the carpals
6. the fusion of the radius and the ulna of the frog
7. the reduction of the first metacarpal of the frog
8. the loss of some digits in the forelimb of the cow
9. the retention of only certain digits in the forelimb of the cow

III TRANSFER OF INFORMATION

EXERCISE G  Describing an evolutionary line

The modern horse (*Equus*) is descended from *Eohippus*, which appeared at the beginning of the Tertiary period.

![Diagram to show the main features of the evolutionary line that leads to the modern horse](image)

*Note that the Cenozoic era is divided into the Tertiary and Quaternary periods, and that each period is divided into epochs. The numbers on the left side indicate millions of years ago.*

PART ONE

We can describe when an ancestor of the modern horse appeared and then say what it evolved into:
Eohippus appeared in the early Eocene and slowly evolved into Orohippus.

Now write similar descriptions of the other seven direct ancestors of the modern horse, numbering your sentences from 1 to 7. Notice that in some cases we find two direct descendants from the same ancestor, and also that some types evolve much more quickly than others. Thus, Orohippus evolved from Eohippus relatively slowly, but it evolved into Epiphippus relatively quickly. Use either slowly or quickly in your sentences. Divide the epochs into early, middle and late periods.

PART TWO

Because evolution is very slow, a new type does not suddenly appear. We can therefore say:

Sometime in the late Eocene, Orohippus evolved from the Eohippus line.

By talking about the 'Eohippus line' we make it clear that Eohippus gradually evolved into forms which were more and more different from it. Now you describe the origins of all the other horses in the diagram, numbering your sentences from 1 to 10.

PART THREE

As Figure 7.4 shows, the number of digits on the forelimb decreased as the horses evolved.

![Diagrams showing the evolution of horse digits](image)

**Figure 7.4** Diagrams to show the number of digits on the forelimb of various ancestors of the horse

We can describe the condition in Eohippus by saying:

The forelimb of the early Eocene horse Eohippus had four digits, number one being reduced to a splint bone.

Now describe the condition in the other four horses, noting that you must describe some digits as being lost.

PART FOUR

We can describe the relationship between succeeding ancestral types by saying:

Eohippus was a four-toed horse which lived in the early Eocene. After some 15 million years it evolved into Orohippus, which also had four toes.

Now write similar descriptions of the relationship between the following:

1. Orohippus (4 toes) : Epiphippus (4 toes)
2. Epiphippus : Mesohippus (3 toes)
3. Mesohippus : Miohippus (3 toes)
4. Miohippus : Parahippus (3 toes)
5. Parahippus : Merychippus (3 toes)
6. Merychippus : Pliohippus (1 toe)
7. Pliohippus : Equus (1 toe)

IV GUIDED WRITING

Here is some information about the modern horse and four of its ancestors:

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<th>Digits of forelimb</th>
<th>Ground</th>
<th>Food</th>
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<td>Equus</td>
<td>6–7 feet</td>
<td>one+two splint bones</td>
<td>dry and hard</td>
<td>tough grasses of climate</td>
</tr>
<tr>
<td>Pliohippus</td>
<td>4–5 feet</td>
<td>one+two splint bones</td>
<td>dry and soft</td>
<td>soft grasses</td>
</tr>
<tr>
<td>Merychippus</td>
<td>4–5 feet</td>
<td>three, but the weight carried only on No. 3</td>
<td>dry and soft</td>
<td>change of climate</td>
</tr>
<tr>
<td>Mesohippus</td>
<td>2–3 feet</td>
<td>three+one splint bone</td>
<td>wet and soft</td>
<td>broad-leaved plants</td>
</tr>
<tr>
<td>Eohippus</td>
<td>12–20 inches</td>
<td>four+one splint bone</td>
<td>wet and soft</td>
<td>broad-leaved plants</td>
</tr>
</tbody>
</table>

We can describe the early history of the evolutionary line of the horse as follows, using information in the table above and some information from Figure 7.3.

Eohippus appeared in the early Eocene, when the ground was wet and soft. It was 12 to 20 inches high and had four digits on its forelimb. There
was also one splint bone, representing the first digit. It fed on the broad-leaved plants that grew at the time.

Mesohippus evolved about 35 millions of years ago. It had only three digits on its forelimb, although the fifth was represented by a splint bone. The climate and the vegetation were still similar to those of the Eocene, and Mesohippus also fed on broad-leaved plants. However, by the middle of the Miocene the climate was drier and soft grasses replaced the broad-leaved plants.

Using the two paragraphs above as examples, write three paragraphs that describe Merychippus, Pliohippus and Equus in a similar way. Do not link your paragraphs to the two above, but start the story again with Merychippus.

V READING AND NOTE-TAKING

Read the passage below and make notes on the main points of the theory that is described.

NATURAL SELECTION

In 1858 Darwin and Wallace together put forward the theory of natural selection, which each had worked out independently of the other. Their theory tries to explain how a species can evolve into one or more different species. It is based upon four observable facts.

First, it is well-known that organisms normally produce more offspring than are needed to replace the parents. For example, a bird like the sparrow may produce 150 or more offspring in its life, and many insects lay a thousand eggs. Some fishes lay much larger numbers of eggs. One, the halibut, lays five million.

The second observation is that the number of individuals of any particular species stays more or less the same from year to year. If we now take this fact together with the observation about the numbers of offspring produced, we can deduce that there must be a high mortality rate (i.e. death rate) during development. In other words, most offspring die before they are adult and before they can themselves reproduce.

The third observation is that there is a wide range of variation among the individuals of any particular species. The most obvious kind of variation is usually in morphology, but we also find differences of anatomy, physiology, and behaviour. From this it is deduced that certain individual members of a species must possess advantages that others lack. For example, if there is a shortage of food, some individuals will have charac-

teristics which enable them to eat more than others. They may be better hunters, or faster runners, or whatever, but the important point is that they can survive when others cannot. If we now take this deduction together with the deduction that the mortality rate during development is high, we can deduce that organisms with advantages have a better chance of becoming adults than do those that lack them.

The final observation is that offspring normally resemble their parents. The argument then says that because the parents are likely to possess advantages, these will be passed on to the offspring. It also follows that disadvantageous variations will not be passed on to offspring, because the individuals which possess them are not likely to survive until they are old enough to reproduce. Thus we can deduce that advantageous variations will be retained from generation to generation, whereas disadvantageous ones will disappear.

It is now clear why we talk of natural selection. We mean by this phrase that nature (in other words, the environment) selects, or chooses, the individuals which will reproduce and so pass on their characteristics. These selected individuals are the ones that are best adapted to their environment. Because the environment may alter, and because individuals may move to places where the environment is different, survival may suddenly come to depend upon quite different characteristics. In such circumstances, descent with modification is then the key to the survival of the species.