I BET YOU DIDN'T KNOW...

Some mammals have unusual backbones

Dr. Alison Trew, PSTT Area Mentor and Website Resources Developer, links **cutting edge research** with the **principles of primary science**

alison.trew@pstt.org.uk

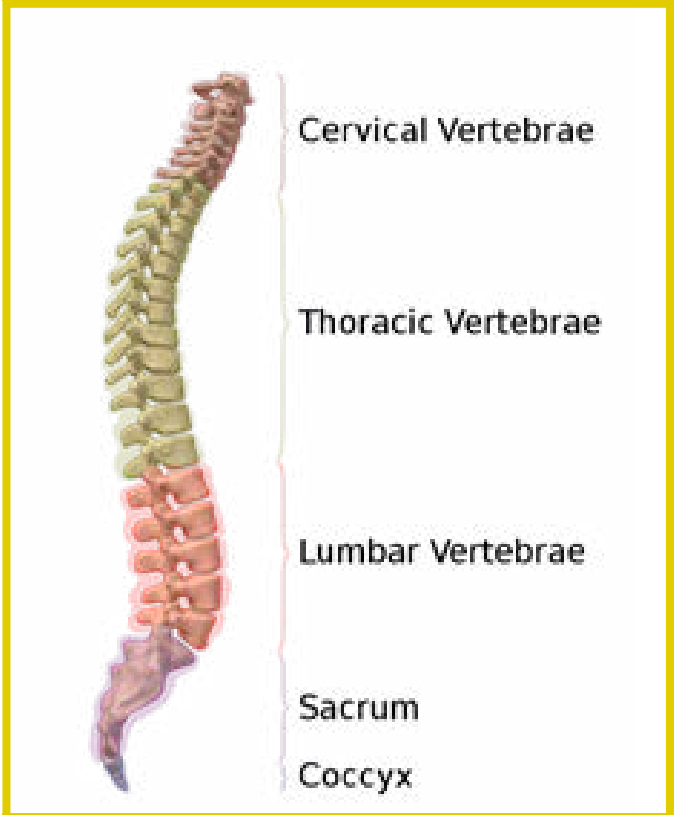
Morphology, in biology, is the study of the size, shape, and structure of animals, plants, and microorganisms and of the relationships of their constituent parts. Comparing the structure of animal bones with their function and motion helps scientists to understand how animals are adapted to their environment and how they might adapt to changes in their environment.

We know that different shaped bones in our bodies have different functions: the skull protects our brain, our ribs protect our heart and lungs, large bones in our legs and arms can carry heavy loads, smaller bones in our hands and feet allow us to manipulate tools.

Questions for children to consider:

- If both our skull and ribs protect important internal organs, why are they so different?
- Why are there so many bones in our backbone (Figure 1)?
- Can you think of examples of how the size and shape of an animal's bones are suited to its behaviour or to its habitat?

Figure 1. The human spinal column has 33 small bones (vertebrae).



https://en.wikipedia.org/wiki/File:Segments_of_Vertebrae.svg
CC BY-SA 4.0
DrJanaOfficial

Sometimes scientists find structures (morphologies) in living organisms that they cannot explain. The hero shrew is a large shrew (12-15 cm) that lives in the forest undergrowth in the centre of Africa and is rarely seen by humans (Figure 2). It has a spinal column unlike that of any other known vertebrate. Most of its backbones (vertebrae) are covered in finger like bumps called tubercles. The bumps from one vertebra interlock with the bumps of the adjacent vertebra forming a dense column (Figure 3). Scientists already know from previous studies that the bottom of the spine behaves as a single rigid bar. As a result, this shrew has an odd walk with its spine flexing in a snake-like manner. Researchers have observed an animal for several months but have been unable to explain a use for this unusual spinal column. The function of this modified spine is mysterious.

Figure 2. A hero shrew (Scutisorex somereni) and a partial skeleton showing the enlarged backbone.

https://commons.wikimedia.org/wiki/File:Scutisorex_somereni_Skelett.jpg
CC BY-SA 3.0
Peter Spelt

To try to find out why this shrew has such an unusual backbone, evolutionary biologists, Stephanie Smith and Kenneth Angielczyk, measured the external and internal features of vertebrae of two species of hero shrew (known simply as hero shrew and Thor's hero shrew) and compared these with the spine of a closely related shrew of a similar size (goliath shrew), which has a more typical mammalian spine.

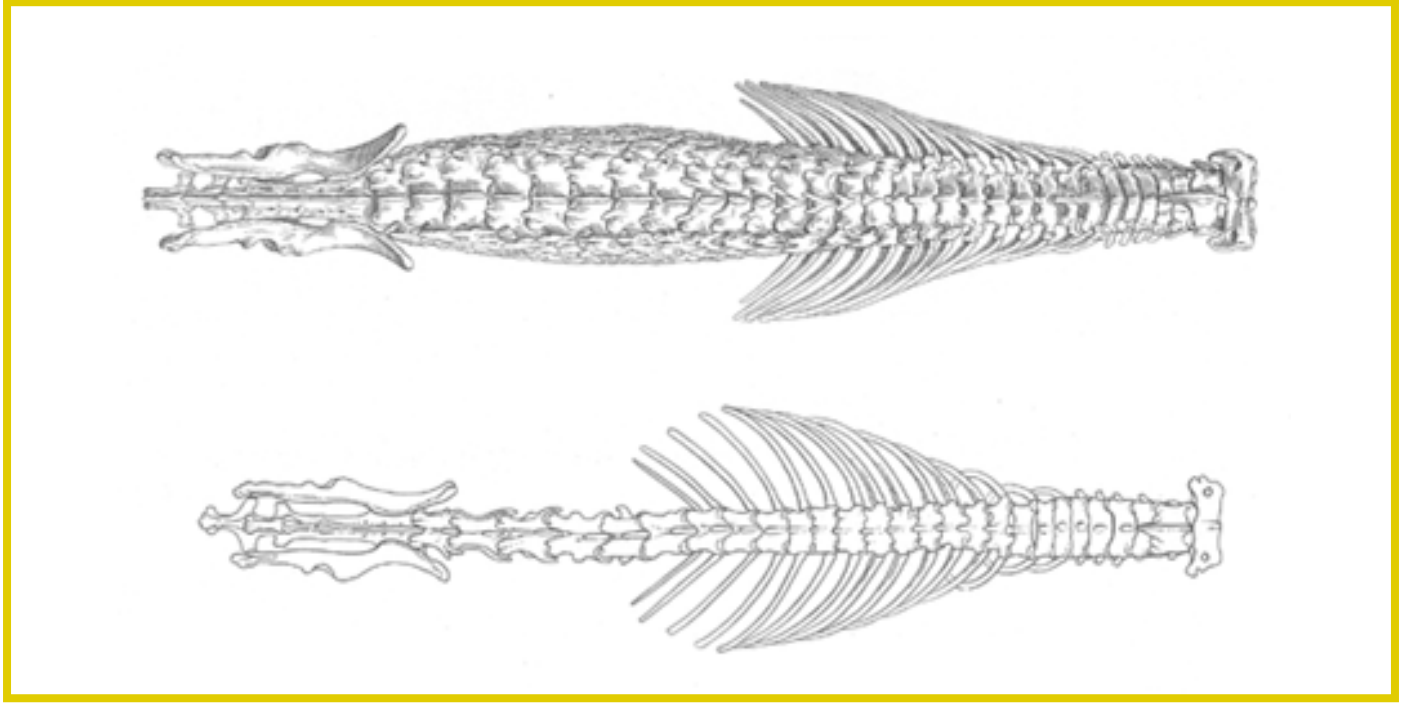
Firstly, adult specimens of twenty shrews from the Field Museum of Natural History in the United States were x-rayed and images of the vertebrae were created using computer programmes. Using these images, the scientists investigated the external structure of the vertebrae: they measured the sizes of individual vertebrae and counted the number of tubercles on the surfaces of each vertebrae.

They found that the different species of shrew had different numbers of vertebrae in the region between the neck and bottom of the rib cage (the thoracic region) (Table 1) but have a similar total spinal column length. The numbers of tubercles on the vertebrae were on average higher in a hero shrew than a Thor's hero shrew but in both species the numbers on each vertebra increased from position 1 (nearer the head) to position 15-17 (nearer the tail).

Table 1. The number of thoracic vertebrae in different species of shrew.

Species	Number of samples	Number of thoracic vertebrae
Hero shrew	13	23-25
Thor's hero shrew	3	22
Goliath shrew	4	19-20

Figure 3. The spine and rib cage of the hero shrew (top) and a typical shrew (bottom).



The scientists also measured features inside each vertebra. The main portion of a vertebral bone, the body (Figure 4), is made of a spongy form of bone containing rod-shaped structures called trabeculae. The structure of the trabeculae can provide information about the physical loads that a bone can withstand in a live animal. The scientists hoped that comparing the trabecular bone structure of the hero shrews and the shrew would help them to understand the function of the hero shrew's spine. They found that the number of trabeculae were higher in both hero shrews (highest in the hero shrew) compared to a goliath shrew. Also, the thickness of the trabecular is greater in the hero shrews than the goliath shrew and mostly increases through the vertebral column in hero shrews, whereas it decreases in the goliath shrew.

From their studies, the scientists concluded that the spines of both hero shrews had evolved to withstand more frequent and greater forces than the more typical spine of the goliath shrew, with the hero shrew having developed a more extreme modification than the Thor's hero shrew.

Although these results do not solve the mystery of how the hero shrew uses its unusual spine, the methods that the scientists have used could be useful for understanding how other small mammals experience forces, and for tracking the evolution of characteristics in extreme vertebrates.

Questions for children to consider:

- Why do you think the hero shrew has a thickened backbone?
- Do you think the hero shrew has an advantage over other shrews that have more 'normal' backbones?
- What would it be like for a human to have vertebrae with many tubercles? How would this change how we move? What advantages/disadvantages might we experience?

Figure 4. Superior view (looking down) of one human thoracic vertebra showing wing-like projections which muscles and ligaments attach to, a hole in the centre which the spinal cord passes through, and a large area of spongy bone called the body.

GLOSSARY

Mammal – a warm-blooded vertebrate animal that has hair or fur, females that produce milk for feeding their young, and (typically) gives birth to live young

Species – a group of living organisms capable of breeding and producing young

Trabecula(e) – rod or pillar-shaped structure(s) that provide support within an organ, for example in bone

Tubercle - a small rounded projection, especially on a bone or on the surface of an animal or plant

Vertebra(e) - small bone(s) forming the backbone, with a hole through which the spinal cord passes

Vertebrate - an animal with a backbone or spinal column

The research paper that inspired this work was:

Deciphering an extreme morphology: bone microarchitecture of the hero shrew backbone (Soricidae: Scutisorex).

By Stephanie M. Smith and Kenneth D. Angielczyk.

Proceedings of the Royal Society of Biology (2020) 287: 20200457.

http://dx.doi.org/10.1098/rspb.2020.0457 Accessed 4.8.20

Both authors work at the Field Museum of Natural History, Chicago, USA.