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Surprising diversity in aging revealed in nature

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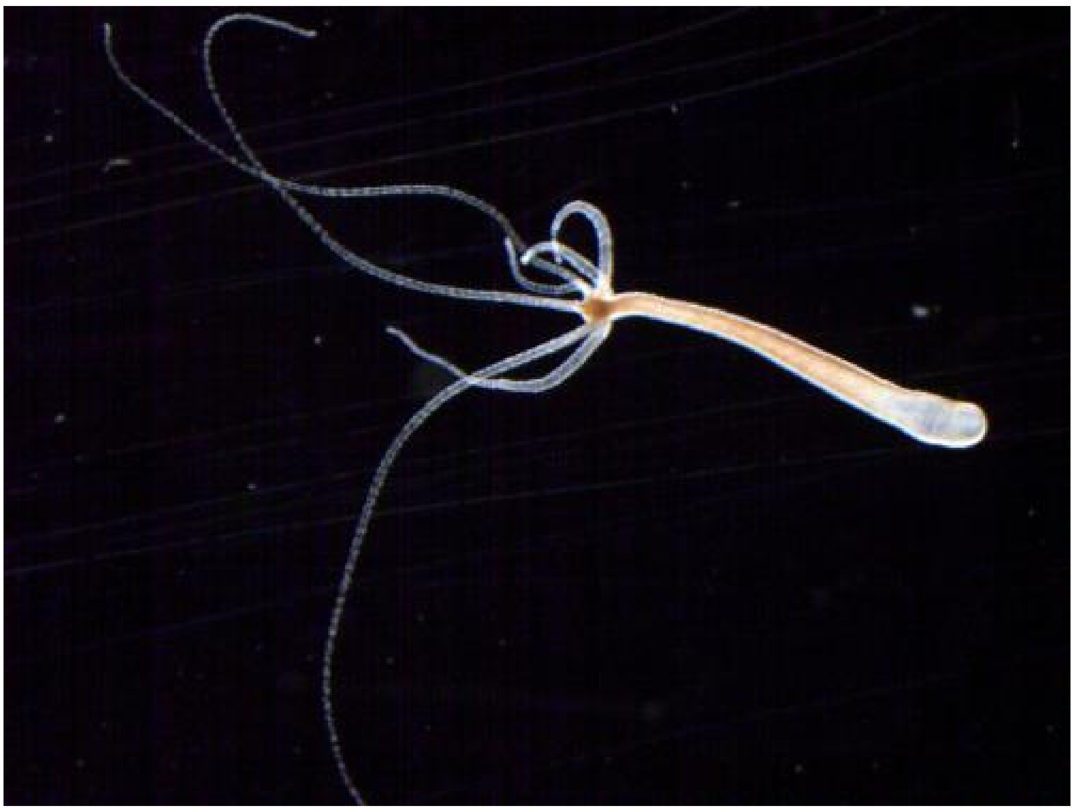

This is the Freshwater polyp *Hydra magnipapillata*. Credit: Ralf Schaible

In our youth we are strong and healthy and then we weaken and die - that's probably how most would describe what ageing is all about. But, in nature, the phenomenon of ageing shows an unexpected diversity of patterns and is altogether rather strange, conclude researchers from The University of Southern Denmark.

Not all species weaken and become more likely to die as they age. Some species get stronger and less likely to die with age, while others are not affected by age at all. Increasing weakness with age is not a law of nature.

Researchers from the University of Southern Denmark have studied ageing in 46 very different species including mammals, plants, fungi and algae, and they surprisingly find that there is a huge diversity in how different organisms age. Some become weaker with age – this applies to e.g. humans, other mammals, and birds; others become stronger with age – this applies to e.g. tortoises and certain trees, and others become neither weaker nor stronger – this applies to e.g. Hydra, a freshwater polyp.

"Many people, including scientists, tend to think that ageing is inevitable and occurs in all organisms on Earth as it does for humans: that every species becomes weaker with age and more likely to die. But that is not the case", says evolutionary biologist and assistant professor Owen Jones from the Max-Planck Odense Center at the University of Southern Denmark .

He is the lead author of an article on the subject in the scientific journal *Nature*. Other authors are from the Max Planck Institute for Demographic Research in Rostock, Germany, the University of Queensland in Australia, University of Amsterdam in Holland and elsewhere.

Owen Jones and his colleagues studied ageing in species ranging from oak trees, nematodes, baboons and lice to seaweed and lions. The species included 11 mammals, 12 other vertebrates, 10 invertebrates, 12 plants and one algae.

"The diversity of mortality and fertility patterns in these organisms surprised us, and there is clearly a need for more research before we fully understand the evolutionary causes of ageing and become better able to address problems of ageing in humans", says Owen Jones.

He points out that while there is plenty of scientific data on ageing in mammals and birds, there is only sparse and incomplete data on ageing in other groups of vertebrates, and most invertebrates, plants, algae, and fungi.

For several species mortality increases with age - as expected by evolutionary scientists. This pattern is seen in most mammal species including humans and killer whales, but also in invertebrates like water fleas. However, other species experience a decrease in mortality as they age, and in some cases mortality drops all the way up to death. This applies to species like the desert tortoise (*Gopherus agassizii*) which experiences the highest mortality early on in life and a steadily declining mortality as it ages. Many plant species, e.g. the white mangrove tree (*Avicennia marina*) follow the same pattern.

Amazingly, there are also species that have constant mortality and remain unaffected by the ageing process. This is most striking in the freshwater polyp *Hydra magnipapillata* which has constant low mortality. In fact, in lab conditions, it has such a low risk of dying at any time in its life that it is effectively immortal.

"Extrapolation from laboratory data show that even after 1400 years five per cent of a hydra population kept in these conditions would still be alive", says Owen Jones.

Several animal and plant species show remarkably little change in mortality throughout their life course. For example, these include rhododendron (*Rhododendron maximum*), great tit (*Parus major*), hermit crab (*Pagurus longicarpus*), common lizard (*Lacerta vivapara*), collared flycatcher (*Ficedula albicollis*), viburnum plants (*Viburnum furcatum*), oarweed (*Laminaria digitata*), red abalone (*Haliotis rufescens*), the plant armed saltbush (*Atriplex acanthocarpa*), red-legged frog (*Rana aurora*) and the coral red gorgonian (*Paramuricea clavata*).

When you look at the fertility patterns of the 46 surveyed species, there is also a great diversity and some large departures from the common beliefs about ageing. Human fertility is characterized by being concentrated in a relatively short period of life, and by the fact that humans live for a rather long time both before and after the fertile period.

A similar pattern of a concentrated fertile period is also seen in other mammals like killer whales, chimpanzees, and chamois (*Rupicapra rupicapra*), and also in birds like sparrow hawks (*Accipiter nisus*).

However, there are also species that become more and more fertile with age, and this pattern is especially common in plants such as the agave (*Agave marmorata*) and the rare mountain plants hypericum (*Hypericum cumulicola*) and borderea (Borderea pyrenaica).

On the contrary fertility occurs very early in the nematode worm *Caenorhabditis elegans*. Actually this species starts its life with being fertile, then it quite quickly and quite suddenly loses the ability to produce offspring.

To sum up there is no strong correlation between the patterns of ageing and the typical life spans of the species. Species can have increasing mortality and still live a long time, or have declining mortality and still live a short time.

"It makes no sense to consider ageing to be based on how old a species can become. Instead, it is more interesting to define ageing as being based on the shape of mortality trajectories: whether rates increase, decrease or remain constant with age", says Owen Jones.

More information: Owen R. Jones et al: Diversity of ageing across the tree of life, *Nature* Dec 8 2013. DOI: 10.1038/nature12789

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