An homage to unusual creatures

The life sciences are dominated by a handful of model organisms, but unusual creatures have their place in biological research as well.

Workhorse model organisms like *Drosophila*, yeast and mice come with a wealth of tools that have been developed to manipulate them. They are easy to breed and rear in the lab. Large communities of scientists work with these organisms, and the resulting body of knowledge about them is enormous. Model organisms have made great contributions to biological insight, and will continue to do so. Yet it is worth also considering organisms other than the traditional ones, especially for particular research questions.

The concentration on a few major model organisms is a relatively recent phenomenon, one that is linked tightly with the development of genetic tools for particular species. Some models were even deliberately selected and developed as such. But half a century ago scientists probably chose their study objects on the basis of different criteria, such as availability or suitability to a particular question. In fact, major scientific breakthroughs were achieved in species that are not studied very much any more, at least compared to the major models. Hubel and Wiesel's seminal studies of the visual system were done in cats. And the relatively simple nervous system of *Aplysia* sea slugs, in combination with the animals' robust behavior, enabled studies of the cellular basis of learning and memory.

Indeed, less prominent organisms may be more suitable to address a particular aspect of biology than established model organisms are. Though they are not nearly as well known as the common lab mouse, contemporary examples do exist. Gerbils are used in auditory research because their auditory system is sensitive to similar frequencies as the human ear. Planarians and axolotls can regrow injured or severed body parts, which makes them interesting systems in which to study regeneration. A more recent addition to the bench is the killifish, a short-lived fish species that may speed up research into vertebrate aging. And tardigrades—'water bears'—are unusually resilient to environmental extremes and can even survive strong X-ray radiation, which could be of interest in DNA-damage research.

In an example in this issue, Shein-Idelson and colleagues make use of the turtle to study local functional connectivity in the brain. The researchers take advantage of the turtle brain's tolerance to oxygen deprivation and the fact that the cortex can be flattened, which allows for long-term high-quality electrophysiological recordings on multi-electrode arrays.

Certain aspects of biology may be missed, or unavailable to study, if research is entirely restricted to select organisms. For example, segmentation in the early *Drosophila* embryo happens all at once, which is probably an adaptation to its fast lifestyle. But other insects, such as beetles of the genus *Tribolium*, sequentially add segments as the embryo develops. And there may be intermediate modes of development. As another example, the visual sense in mice is not as strongly developed as that in humans or macaques, because of their nocturnal lifestyle. Mice are therefore less than ideal models for studying color vision.

Studying only a handful of models could result in the loss not only of technical expertise on more unusual organisms, but of the very awareness of particular features that could be the entry point into biological insight. Countering this trend, as experimental tools develop, more and more organisms are becoming tractable for molecular genetic studies. The CRISPR–Cas system, in particular, has been applied well beyond the standard model organisms, making it possible to conduct functional studies in more species. Genome editing has been applied in butterflies to study wing and photoreceptor patterning, for example, and has been used to determine the role of a particular gene in shaping social behaviors in ants. And large-scale RNA sequencing is now easily accessible, so that the effects of genetic and environmental manipulations can be analyzed at the transcriptome level.

Finally, exploring a diversity of biological form and function has an excellent record in yielding useful tools, which may in turn be employed in model and nonmodel organisms alike. A prominent example is the now ubiquitous channelrhodopsin, which originates from a green alga and is widely used to manipulate neuronal activity. Fluorescent proteins such as GFP and mCherry were isolated from jellyfish and corals, respectively. And modern molecular biology would not be possible without heat-stable DNA polymerases from thermophilic bacteria.

The major model organisms will remain central in basic biomedical research. But we would do well to keep an open mind to the tangled bank of biology in all its vastness and complexity.