FAO estimates that Brazil alone spends US$600 million each year on controlling infestations.

Africa has its own species of armyworm, *Spodoptera exempta*, which devours the leaves of crops such as maize. But the invasive fall armyworm is especially worrisome because it also consumes a plant's reproductive parts, eating through the maize cob itself and resulting in even more crop loss.

African scientists are now mobilizing their efforts to study the fall armyworm as it moves across different regions. "Although the basic biology of the insect remains similar, confrontation of the pest by different environmental conditions and host plant ranges may cause the pest to react differently," says Johnnie van den Berg, a zoologist at North-West University in Potchefstroom, South Africa.

Van den Berg and two colleagues will head research on the ecology of the pest in South Africa. This will include studies into the efficacy and management of the fall armyworm on a form of genetically modified (GM) maize called *Bt* maize. This crop is widely grown in the country, and the hope is that it may be more resistant to the pest than conventional maize — as experience in Brazil has demonstrated. The ecology study will examine the fall armyworm's behaviour on locally grown plants other than maize, and investigate how it fares in South Africa's dramatically varying climate zones.

The researchers will also study the efficacy of commercially available insecticides that have been rushed through an ongoing emergency-registration process to tackle the pest.

"It is likely that the fall armyworm will spread from its current distribution throughout sub-Saharan Africa fairly rapidly," warns Ken Wilson, an ecologist at Lancaster University, UK. "From there, it is but a hop, skip and jump to southern Europe."

Because the caterpillar can live on such a wide variety of plants, it is likely to persist year-round in southern Europe. So it is "not unreasonable" to expect it to migrate through to Eastern Europe and Asia, or to be transported there by agricultural export, adds Wilson, who will be working with the University of Zambia in Lusaka to assess the damage caused by the fall armyworm.

Although no one knows how the insect got to Africa, increased trade and climate change are the likely culprits, say experts.

The drought linked to the El Niño weather system of 2014–16, followed by the current high rainfall associated with the La Niña system, created the "perfect conditions" for armyworm outbreaks in Africa, says Wilson.

"With global climate change, we can probably expect more of these fluctuations in temperature and rainfall," he says. "In addition, with increased global trade and travel, we can expect greater movement of pests within and between continents."

Mulila-Mitti notes that the FAO has observed a rise in the spread of invasive species, particularly in sub-Saharan Africa.

Last year, a team led by ecologist Dean Paini of Australia's Commonwealth Scientific and Industrial Research Organisation in Canberra analysed 1,300 invasive species, along with countries' main crops and international trade routes (D. R. Paini *et al. Proc. Natl Acad. Sci. USA* **113,** 7575–7579; 2016). The study found that sub-Saharan African countries were the most vulnerable to invasive species. ■

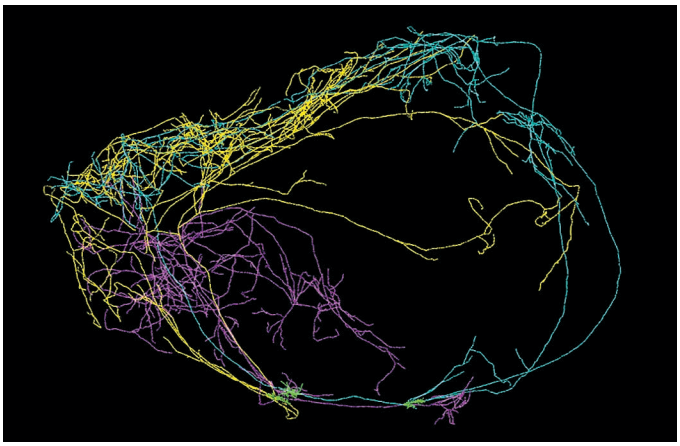
NEUROSCIENCE

Giant neuron encircles entire brain of a mouse

The 'crown of thorns'–shaped cell stems from a region linked to consciousness.

BY SARA REARDON

Like ivy plants that send runners out searching for something to cling to, the brain's neurons send out shoots that connect with other neurons throughout the organ. A new digital reconstruction method shows three neurons that branch extensively throughout the brain, including one that wraps around its entire outer layer. The finding could help to explain how the brain creates consciousness.



ALLEN INST. BRAIN SCI.

A digital reconstruction of a neuron that wraps around the mouse brain.

Christof Koch, president of the Allen Institute for Brain Science in Seattle, Washington, explained his group's technique at a meeting on 15 February of the Brain Research through Advancing Innovative Neurotechnologies initiative in Bethesda, Maryland.

He showed how the team traced three neurons from a small, thin sheet of cells called the claustrum — an area that Koch believes acts as the seat of consciousness in mice and humans (F. C. Crick & C. Koch *Phil. Trans. R. Soc. Lond. B* **360,** 1271–1279; 2005).

Tracing all the branches of a neuron using conventional methods is a massive task. Researchers inject individual cells with a dye, slice the brain into thin sections and then trace the dyed neuron's path by hand. Very few have been able to trace a neuron through the entire organ. The new method is less invasive and is also scalable, saving time and effort.

Koch and his colleagues engineered a line of mice so that a certain drug activated specific genes in claustrum neurons. When the researchers fed the mice a small amount of the drug, only a handful of neurons received enough of it to switch on these genes.

That resulted in production of a green fluorescent protein that spread throughout the entire neuron. The team then took 10,000 cross-sectional images of the mouse brain and used a computer program to create a 3D reconstruction of just three glowing cells.

The three neurons stretched across both brain hemispheres, and one of the three wrapped around the organ's circumference like a "crown of thorns", Koch says. He adds that he has never seen neurons extend so far across brain regions.

WELL CONNECTED

The mouse body contains other long neurons, such as a nerve projection in the leg and neurons from the brainstem that thread through the brain to release signalling molecules. But these claustrum neurons seem to connect to most or all of the outer parts of the brain that take in sensory information and drive behaviour.

Koch sees this as evidence that the claustrum could be coordinating inputs and outputs across the brain to create consciousness. Brain scans have shown that the human claustrum is one of the most densely connected areas of the brain (C. M. Torgerson *et al. Hum. Brain Mapp.* **36,** 827–838; 2015), but those images do not show the path of individual neurons.

The claustrum is a good brain region in which to test the new technique because it has been extensively studied in mice and consists of only a few cell types, says James Eberwine, a pharmacologist at the University of Pennsylvania in Philadelphia.

TAKING STOCK

"It's quite admirable," Rafael Yuste, a neurobiologist at Columbia University in New York City, says of the method. He doesn't think that the existence of neurons encircling the brain definitively proves that the claustrum is involved in consciousness.

But he says that the technique will be helpful for censuses that identify different cell types in the brain, which many think will be crucial for understanding how the organ functions. "It's like trying to decipher language if we don't understand what the alphabet is," he says.

Yuste and Eberwine would like to see 3D reconstructions of individual neurons compared with analyses of the genes expressed in those neurons. This might offer clues to the type and function of each cell.

It is also unclear whether these gene-expression patterns correlate with the shape of the neuron, Yuste says. Imaging techniques such as that developed by the Allen Institute should help researchers to work out whether such a correlation exists.

Koch plans to continue mapping neurons emanating from the claustrum, although the technique is too expensive to be used to reconstruct all of these neurons on a large scale. He would like to know whether all the region's neurons extend throughout the brain, or whether each neuron is unique, projecting to a slightly different area. ■

PUBLIC HEALTH

Drug-resistant bacteria ranked

World Health Organization hopes list will drive development of much-needed antibiotics.

BY CASSANDRA WILLYARD

The World Health Organization (WHO) has for the first time released a list of the drug-resistant bacteria that pose the greatest threat to human health and for which new antibiotics are desperately needed.

The agency's aim in listing these 'priority pathogens' is to steer funds towards development of the most crucial antimicrobials. Researchers say the list is a useful reminder of the danger of bacteria that are becoming resistant to antibiotics.

The list ranks 12 bacteria or bacterial families and is topped by carbapenem-resistant *Acinetobacter baumannii*, an obscure bacterium that causes a severe infection for which almost no treatments exist, and that mainly affects people who are already critically ill. (It is resistant to carbapenem antibiotics, 'last resort' drugs used only when all other treatments have failed.) The ranking also includes several other multidrug-resistant pathogens that cause infections in hospitals, as well as better-known bacteria, such as those responsible for pneumonia and gonorrhoea (see 'Threat list').

Antibiotic resistance kills an estimated 700,000 people each year worldwide, and some experts predict that number could rise to 10 million by 2050 if efforts are not made to curtail resistance or develop new antibiotics. Despite an urgent need for these drugs, the once-robust development pipeline for antibiotics now produces little more than a trickle of viable compounds. As of September 2016, about 40 new antibiotics were in clinical development for the US market, compared with hundreds of cancer drugs.

> ***"The low-hanging fruit has been plucked."***

Many drug companies see antimicrobials as a losing proposition. "Most infections are still sensitive to existing drugs," says Allan Coukell, who oversees an antibiotic-resistance initiative at the Pew Charitable Trusts in Washington DC. "And if you have a new antibiotic, you do really want to hold it in reserve for those resistant infections." That means the market for new antibiotics is relatively small, and companies might not sell enough of the medicines to recoup their costs.

To create the list, a small team comprising WHO experts and researchers in the Division of Infectious Diseases at the University of Tübingen, Germany, started with similar rankings that already exist, including a 2013 list from the US Centers for Disease Control and Prevention, and a 2016 Canadian version. The team considered factors such as the pathogens' deadliness, their level of resistance and how easily they spread.

The panel excluded microbes that can be addressed effectively by other measures, such as good sanitation or vaccination. That gave a list of 20 bacteria from 12 families. To rank them, the team handed data on each to 70 experts from around the world — but did not provide the pathogens' names, in an effort to avoid bias.

Coukell says the WHO's list is useful, but it doesn't mean that drug developers are going to start at the top and work their way down. Developing antibiotics poses scientific and economic challenges. And in terms of drug discovery, says Brad Spellberg, an infectious-disease specialist at the Keck School of Medicine at the University of Southern California, Los Angeles, "the low-hanging fruit has been plucked". ■

THREAT LIST

Bacterium or bacterial family (and antibiotics it resists) ranked by threat to human health

Acinetobacter baumannii (carbapenem)
Pseudomonas aeruginosa (carbapenem)
Enterobacteriaceae, extended-spectrum-β-lactamase-producing (carbapenem)
Enterococcus faecium (vancomycin)
Staphylococcus aureus (methicillin, vancomycin)
Helicobacter pylori (clarithromycin)
Campylobacter spp. (fluoroquinolone)
Salmonellae (fluoroquinolone)
Neisseria gonorrhoeae (cephalosporin, fluoroquinolone)
Streptococcus pneumoniae (penicillin-non-susceptible)
Haemophilus influenzae (ampicillin)
Shigella spp. (fluoroquinolone)

SOURCE: WHO