lucrative contracts with international research consortia. "Industry is very important for us," says Karina Angelieva, adviser for education and research at Bulgaria's permanent representation to the EU, in Brussels.

RAISED SCRUTINY

These plans are now at risk, unless Bulgaria can persuade the EU's regional-policy directorate general to release the frozen funds. Meanwhile, the 2018 science and higher education budget stands at 2013 levels: just 415 million leva (US$263 million), plus another 98 million leva for the Bulgarian Academy of Sciences.

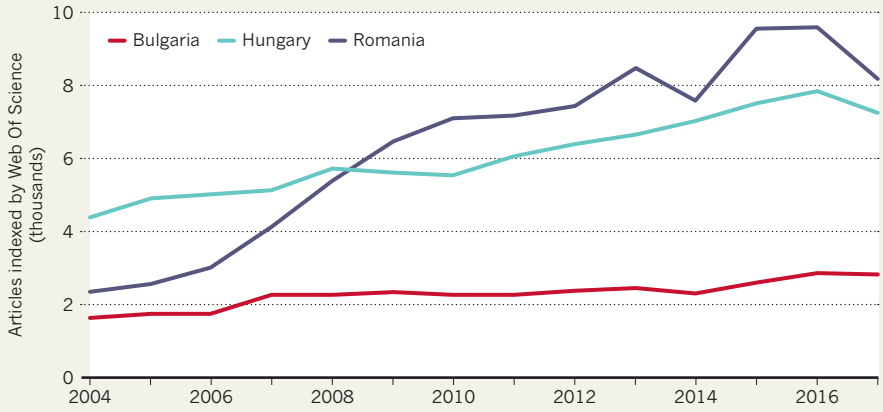
The financial difficulties also threaten Bulgaria's national research-infrastructure road map, which was published in June 2017. Kostadin Kostadinov, an adviser to the country's science and education minister, Krasimir Valchev, says that the road map "will increase research potential in Bulgaria according to the needs of local industry and regional development", and that it is part of a plan ultimately to raise the country's total science spending to 1.5% of gross domestic product (GDP). That figure currently stands at 0.96% of GDP, which is less than half the EU average.

Problems with science funding are exacerbated by corruption, say several scientists. Not only is Bulgaria the poorest country in the EU, it is also the most corrupt, according to Berlin-based lobby group Transparency International. Proykova says that science is rarely directly affected by monetary fraud, but corruption makes itself felt in procurement. "For example, things are never delivered to the lab, even though the money has been transferred," she says. "Or, you get less good equipment for the same money, because the company takes some of the funds."

Some scientists see Bulgaria's turn in the EU presidency as a chance for change. Lidia Borrell-Damián, director for research and innovation at the European University Association in Brussels, says that it provides an opportunity for Bulgaria's universities to connect with others. Daniel Smilov, a political scientist at Sofia University, hopes that the presidency will put the country's problems on the map, forcing change from outside that has been lacking from within. "It is an important moment," he says, "because our visibility will be great." ■

BULGARIA'S OUTPUT LAGS BEHIND

Efforts to boost science in the European Union's poorest country have been undermined by a lack of funds. Bulgaria's production of published research has risen at a slower rate than that of its neighbours.



SOURCE: WEB OF SCIENCE

DNA SEQUENCING

Super-invasive crayfish revealed to be a genetic hybrid

Scientists examine DNA of a marbled crayfish that is spreading ferociously.

EWEN CALLAWAY

Molecular biologists have sequenced the genome of an invasive species of crayfish that can reproduce without mating and is spreading rapidly across Madagascar. The marbled crayfish (*Procambarus virginalis*) was first spotted in aquariums in Germany in the 1990s. Now, DNA sequencing suggests that the species is probably the product of two distantly related members of a different crayfish species, the team reported on 5 February in *Nature Ecology and Evolution*[1].

The marbled crayfish has already been banned in the European Union and some parts of the United States because of the threat it poses to freshwater ecosystems. The species has now spread into the interior of Madagascar and risks crowding out seven native crayfish species. "This is a very aggressive population," says Frank Lyko, a molecular biologist at the German Cancer Research Center in Heidelberg, who co-led the study. "If the marbled crayfish continues to explode at its current pace, it will probably outcompete endemic species."

"If the marbled crayfish continues to explode at its current pace, it will probably outcompete endemic species."

The marbled crayfish carries three copies of each chromosome, instead of the usual two[2]. Lyko and his team sequenced the genome of a single individual from a laboratory strain known as Petshop. Its DNA revealed a surprise: it had two different genotypes at many places in its genome. The best explanation for this pattern, says Lyko, is that two of the chromosomes are nearly identical in sequence, but the third differs substantially.

The two distinct genomes are closely related to those of another freshwater crayfish, *Procambarus fallax*, native to Florida and popular with aquarists. Lyko speculates that marbled crayfish emerged when the genome of a sperm or egg of one *P. fallax* individual became duplicated, which can happen in response to sudden changes in temperature. If this cell was then fertilized by another individual living in the same aquarium, it would have resulted in an embryo with three copies of its genome, says Lyko. This would represent a new species. Lyko says that the first marbled crayfish was probably born in an aquarium in either Germany or the United States, and its offspring widely shared between fish collectors.

The first scientific description of the marbled crayfish appeared in 2003, in a *Nature* paper[3] showing that all members of the ▶

RANJA ANDRIANTSOA

The marbled crayfish threatens to crowd out seven native species in Madagascar.

species they surveyed were female and reproduced through parthenogenesis — a process by which an unfertilized egg develops into an adult with a genome identical to its mother's. How the first marbled crayfish gained the ability to reproduce through parthenogenesis is a mystery, says Lyko.

To better understand the species' spread, Lyko's team did more-limited DNA sequencing of 49 individuals caught across Madagascar. These studies showed a stunning lack of genetic diversity, owing presumably to the species' recent origin and ability to reproduce through parthenogenesis.

Julia Jones, a conservation scientist at Bangor University, UK, led the team that first surveyed[4] the spread of marbled crayfish in Madagascar after their discovery in 2007. She says that the species' spread is due largely to their popularity as a food source. In 2009, she met a man on a bus carrying a plastic bag full of them that he planned to dump into his rice fields in the hope of creating a sustainable stock, she says.

Stopping their spread in Madagascar will be "almost impossible", says Lyko. Collaborators there have begun campaigns urging people not to transport the creatures or release them into rice fields. The message is a hard sell in a country where poverty levels are high and marbled crayfish are a cheap and popular source of protein. Lyko's colleague brought a few dozen that she had caught to a family barbecue. "This went down quite well," he says. ■

1. Gutekunst, J. *et al. Nature Ecol. Evol.* http://dx.doi.org/10.1038/s41559-018-0467-9 (2018).
2. Martin, P., Thonagel, S. & Scholtz, G. *J. Zool. Syst. Evol. Res.* **54,** 13–21 (2016).
3. Scholtz, G. *et al. Nature* **421,** 806 (2003).
4. Jones, J. P. G. *et al. Biol. Invasions* **11,** 1475–1482 (2009).

CORRECTION

The News Feature 'The science that's never been cited' (*Nature* **552,** 162–164; 2017) originally included a link to the data behind the charts. *Nature* has subsequently been told that the data are not available to make public, so the link has been removed online.

CORRECTION

The News story ‘Super-invasive crayfish revealed to be a genetic hybrid’ (*Nature* **554,** 157–158; 2018) incorrectly stated that Julie Jones was the first to identify marbled crayfish in Madagascar. In fact, another team made the discovery; Jones and her team were the first to survey its spread in the nation.