EDITED BY KRISTEN MUELLER AND MARIA CRUZ

PLANT SCIENCES

An Inside View of Infection

Huanglongbing, or citrus greening, which is caused by bacteria transmitted by psyllid insects, has devastated citrus trees in Asia and Africa and is becoming a considerable threat in North America. Affected trees produce damaged fruit and typically will die within a few years. Several control measures have been brought into play but with little effect. Chiyaka *et al*. have now developed a mathematical model of citrus greening that may lead to more effective control strategies. Key to the model is considering the diseased entity to be not the whole tree, but rather the flush, a new growth of young leaves that the psyllid insects find particularly attractive. The model generated several outcomes that match observed disease characteristics: that rapid movement of the bacteria within the tree results in death in about 5 years, and that the numbers of psyllid insects decline after the infection is well established. Some indications from the model suggested that nutritional support to the tree can help the tree sustain some healthy flush. Other indications suggest that insecticidal spraying is most effective when applied frequently and early in an infection. By designating the flush as the diseased entity, the authors leave room to consider infection spread within a tree, which can occur without the psyllid vector. — PJH

Proc. Natl. Acad. Sci. U.S.A. **109**, 12213 (2012).

ASTRONOMY

A Spiral Unraveled

The origin of the spiral arms seen in galaxies is not fully understood. One long-standing theory posits that these bright, long, thin regions are manifestations of a long-lived density wave that moves with a constant angular speed. In the inner part of the galaxy, the stars and gas move faster than this density wave; in the outer part, the reverse is true. As gas moves into regions

of higher density, it can get compressed and form stars. According to the density wave theory, these newly formed stars should appear slightly ahead of the arm traced by gas in the inner part of the galaxy and slightly behind in the outer part. To test this prediction, Ferreras *et al*. analyzed the properties of 787 star-forming regions in the spiral structure of NGC 4321 (or M100), a nearby galaxy with well-defined spiral arms. Using observations at different wavelengths to trace recently formed stars of different ages, they found that the distribution of stellar ages around the spiral arms does not follow the radial trend predicted by theory. For this galaxy, the data are consistent instead with short-lived spiral arms that corotate with the gas and the stars—thus adding to the evidence against the spiral density wave theory. — MJC

Mon. Not. R. Astron. Soc. 10.1111/j.1365-2966.2012.21017.x (2012).

PHYSICS

Bond Valence Under Pressure

Many chemical elements display different valence states in the different compounds that they form. Some, like rare earths and actinides, can also have a mixed valence state within a single compound if the difference in energies between the competing states is small. Often, the valence state is deduced from structural data by assuming a simple dependence on the bond lengths. Souza-Neto *et al*. demonstrate that there is a big discrepancy between the results obtained from this bond-valence model and the direct measurements of the valence state of Eu in the compound EuO under pressure. At about 44 GPa, this oxide undergoes a transition from an NaCl-like to a CsCl-like structure, wherein the two phases coexist; above 59 GPa, only the CsCl phase remains. The authors found a mixture of $Eu^{2+}$and Eu^{3+} in the intermediate-pressure regime, and a near recovery of a homogeneous Eu^{2+} valence state above 59 GPa, despite a 7% volume collapse associated with the structural transition; the bond-valence model based on structural data predicts a much higher valence. The results support probing of both structure and electronic states in mixed-valence systems. — JS

Phys. Rev. Lett. **109**, 026403 (2012).

EDUCATION

Math + Science = Success

Is there any truth to the idea that biology students are interested in science yet are apprehensive about math? Llamas *et al*. analyzed 10 years of test results from undergraduate students enrolled in a plant physiology course in Spain. Only a basic level of mathematics knowledge appropriate to the students' background was required for answering the test questions. Questions requiring mathematical skills were defined as those that required calculations, interpretation of graphs, or analysis of a numeric table. Success on these questions was found to be 16% lower than success on corresponding nonmathematical questions. Moreover, mathematics-based questions were more often left blank, which suggests that the students themselves may doubt their ability to answer the question. Interestingly, success on mathematics questions ran in parallel with success in the course. These results highlight the need to integrate mathematical literacy into undergraduate biology courses to help students apply previously acquired skills to enhance their interest, and success, in biology. — MM

Biosci. Educ. Electron. J. **19** (2012).

Published by AAAS