D. PHILLIPS/AP PHOTO/NEW MEXICO STATE UNIV.

Al Tombaugh, the son of Pluto's discoverer, was among those defending its planetary status in 2006.

ASTRONOMY

The planet that never was

Neil deGrasse Tyson enjoys a passionate and personal account of the demotion of Pluto.

It is not often that people assert they have committed a capital crime. The confessed 'felon' in this case is astronomer Michael Brown of the California Institute of Technology in Pasadena. In *How I Killed Pluto and Why It Had It Coming*, he describes how his discovery of another icy body challenged Pluto's status as a planet.

The first seed of Pluto's undoing was sown on 13 March 1930, the day its discovery was announced by the Lowell Observatory in Flagstaff, Arizona. Clyde Tombaugh, a Kansas farm-boy-turned-astronomer, claimed to have found the mythical Planet X predicted by his predecessor Percival Lowell. Or had he?

If you are looking for something already named Planet X and you find it, then surely that object will get classified as a planet. And thus, Pluto was first reported to be at least as large and as massive as Earth. This was based not on a measurement, but on the assumption that Pluto's gravity was sufficient to perturb Neptune's orbit in exactly the ways observed.

Pluto orbits sufficiently far from the Sun that all but the most advanced telescopes on Earth see it as a smudge of light. One way to measure its size is by occultation: from the time it takes Pluto to cross our line of sight to a distant star, astronomers can easily derive a lower limit for how big Pluto must be.

The problem was, every attempt to measure Pluto's shadow showed no dimming of the background star. Either Pluto was strangely transparent or it was much smaller than thought. Estimates for the planet's size kept shrinking over the decades, with a rapidity that led some wags to extrapolate (complete with a fitting function and graph) the exact date at which Pluto would disappear completely.

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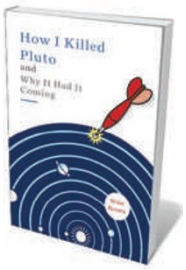
For a fictional take on the discovery of Pluto, see:
go.nature.com/xj483l



How I Killed Pluto and Why It Had It Coming
MIKE BROWN
Spiegel and Grau: 2010. 288 pp. $25

Pluto's size was not settled until the late 1970s, when our view of its orbit allowed James Christy of the US Naval Observatory in Flagstaff to discover its moon, Charon. From orbits and eclipse measurements, planetary scientist Richard Binzel and his collaborators discerned the masses and sizes of both bodies. Pluto was tiny. An orb measuring 2,300 kilometres across, it was not only much smaller than Earth, it was smaller than seven moons in the Solar System, with a mass equivalent to a mere 17% of our Moon.

Puny Pluto never justified its designation as the mythical Planet X. Had its true size been known to Tombaugh, he might never have classified it as a planet. The very data that led to its discovery were also challenged in 1993, when E. Myles Standish found from a re-analysis of archival observing logs at the US Naval Observatory that nothing was wrong with Neptune's orbit all along. There was no need for a perturbing Planet X. So what was Pluto?

Size alone should not be a principal factor in defining a planet — if it were, Earth could lose out too. For instance, Jupiter is 11 times wider than Earth, but Earth is only 5.5 times wider than Pluto. So Jovians might think Earth puny. For many astronomers, physical and orbital characteristics matter greatly, but in the hearts and minds of some, size still matters. That is where Brown enters the picture. In *How I Killed Pluto and Why It Had It Coming*, he explains where Pluto sits in the hierarchy of the Solar System and whether it deserves to be called a planet at all.

We learn about the 1992 discovery by astronomers David Jewitt and Jane Luu of the Kuiper belt that lies beyond Neptune — thousands of small, frozen objects that never coalesced from gravitational attraction. Pluto lives among them. Brown reasoned, as others had before, that if Pluto is large among these icy bodies yet orbits on the inner edge of the Kuiper belt, then larger objects could exist farther out that escape detection. He set out to find them. With the telescopic muscle of Caltech's observatories and plenty of youthful ambition, Brown was poised to make the discovery that transformed his life and the fate of Pluto.

Part memoir and part planetary saga, Brown's book invites you into his office, his home and his head. The account of his hard work, long hours and lost sleep reveal a dedicated researcher on a mission. He reflects on love and passion, including a charming account of how he met, courted and married his spouse. We learn about the birth of his daughter and how these domestic elements pierce his life as a scientist.

Brown's confessed crime is his 2005 discovery of Eris, an icy Kuiper-belt object that, by early estimates, was slightly larger than Pluto. What should we call it? If Eris is not a planet then it must drag Pluto down with it into the ranks of non-planethood. If we call it a planet, then Brown becomes one of only four people to have discovered one. Even he is too modest to claim that his name should hang alongside William Herschel, discoverer of Uranus, or Johann Gottfried Galle, discoverer of Neptune.

Actually, Pluto's planet status had been percolating for years. Diminutive size was only one of many factors in its demotion. Pluto's oddly tipped, elongated orbit and its icy constitution also raised eyebrows. With the discovery of the Kuiper belt, the need for an official decision grew urgent. In August 2006, at the triennial meeting of the International Astronomical Union (IAU) in Prague, a formal vote was taken on the definition of a planet.

What emerged was simple yet devastating to Pluto-lovers. Does the body mainly orbit the Sun? Is it large enough to pull its own mass into a sphere? Is its gravity strong enough for it to have (mostly) cleared its orbit of debris? Answer yes to all three and it's a planet. Given the known existence of the Kuiper belt, Pluto (and Eris) would fail the debris-free orbit criterion. And so a new term was invented for round objects that orbit in crowded places: dwarf planet.

Measurements of Eris's size from a November 2010 occultation may leave Eris slightly smaller than Pluto, instead of slightly larger as Brown had previously determined. Although this revelation has resurrected the efforts of some Pluto defenders, the IAU definition remains robust against arguments of size.

So although Brown did not kill Pluto all by himself, he is guilty of providing wood and nails to construct its coffin. And my museum colleagues and I have someone to whom we can forward the hate mail we still get from Pluto-loving schoolchildren. ■

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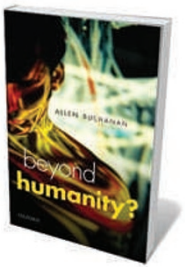
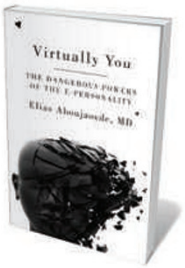
Further reading accompanies this article online at go.nature.com/c9ggk9.

Books in brief

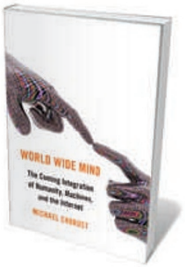


Beyond Humanity?: The Ethics of Biomedical Enhancement
Allen Buchanan OXFORD UNIVERSITY PRESS *256 pp. $25 (2011)*
Since humans developed tools, we have sought to improve our performance through technology. Enhancements using biotechnologies should be seen in the same evolutionary context, argues philosopher Allen Buchanan. Increasing our memory, cognitive power, stamina or resistance to disease using drugs and genetic editing offers sufficient benefits to our species that we should set aside objections. He urges that evolutionary biology should be included in ethical debates about biotechnology and enhancement.

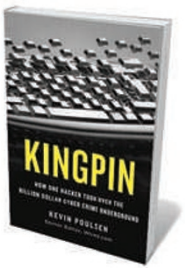
Alone Together: Why We Expect More from Technology and Less from Each Other
Sherry Turkle BASIC BOOKS *384 pp. $28.95 (2011)*
The illusion of companionship fostered by technology is the focus of sociologist Sherry Turkle's latest book. From Facebook to robots, she examines how social networks give us 'friends' without the demands of intimacy, and how virtual environments allow us to overcome risk without consequences. Despite taking increasing hold of our lives, she argues, computers and robots will ultimately result in isolation, reduced privacy and diminished social skills. Yet she hopes that, by asking new questions, the young will overcome these downsides.



Virtually You: The Dangerous Powers of the E-Personality
Elias Aboujaoude W. W. NORTON *349 pp. $26.95 (2011)*
Just as the persona we present to our work colleagues and our family differs, psychiatrist Elias Aboujaoude argues that we show a separate character online. From studying patients who have become mentally disturbed through excessive Internet use, he examines the construction of this e-personality, which reveals itself in the style of our e-mails, the users we associate with in our social networks and our online shopping habits. The impatient, urgent and unfocused nature of Internet usage also seeps into our offline world, he argues.



World Wide Mind: The Coming Integration of Humanity, Machines, and the Internet
Michael Chorost FREE PRESS *256 pp. $26 (2011)*
Having relied since 2001 on bionic ear implants for his hearing, science writer Michael Chorost offers a personal account of the borderline between humans and machines. After exploring the technologies that might be used to fix or enhance our bodies, with a focus on brain implants, he argues that such technologies need not depersonalize us. As well as overcoming physical problems, embedded brain chips might one day transform human communication by literally plugging us into the World Wide Web.



Kingpin: How One Hacker Took Over the Billion-Dollar Cybercrime Underground
Kevin Poulsen CROWN *288 pp. $25 (2011)*
Hacker-turned-journalist Kevin Poulsen investigates cybercrime in his latest book. He spotlights a notorious figure who took over a giant online criminal network and siphoned off millions of dollars from the US economy. Sought by the FBI worldwide, the hacker turned out to be security consultant Max Butler. Poulsen portrays both sides of the story and exposes the range of ongoing frauds, from phishing to Trojan viruses to counterfeiting.