2. Burrows, M. & Hoyle, G. *J. Exp. Zool.* **179,** 379–394 (1972).
3. Alexander, R. M. & Bennet-Clark, H. C. *Nature* **265,** 114–117 (1977).
4. Bennet-Clark, H. C. in *The Insect Integument* (ed. Hepburn, H. R.) 421–443 (Elsevier, Amsterdam, 1976).
5. Gronenberg, W. *J. Comp. Phys. A* **178,** 727–734 (1996).
6. Alexander, R. M. *Comp. Biochem. Phys. A* **133,** 1001–1011 (2002).
7. Brennen, C. E. *Cavitation and Bubble Dynamics* (Oxford University Press, New York, 1995).
8. Lohse, D., Schmitz, B. & Versluis, M. *Nature* **413,** 477–478 (2001).
9. Versluis, M., Schmitz, B., von der Heydt, A. & Lohse, D. *Science* **289,** 2114–2117 (2000).
10. Currey, J. D., Nash, A. & Bonfield, W. *J. Mater. Sci.* **17,** 1939–1944 (1982).

Supplementary information accompanies this communication on *Nature*'s website.
Competing financial interests: declared none.

Origin of AIDS

Contaminated polio vaccine theory refuted

Despite strong evidence to the contrary[1–5], speculation continues that the AIDS virus, human immunodeficiency virus type 1 (HIV-1), may have crossed into humans as a result of contamination of the oral polio vaccine (OPV)[6–8]. This 'OPV/AIDS theory' claims that chimpanzees from the vicinity of Stanleyville — now Kisangani in the Democratic Republic of Congo — were the source of a simian immunodeficiency virus (SIVcpz) that was transmitted to humans when chimpanzee tissues were allegedly used in the preparation of OPV[6,7]. Here we show that SIVcpz is indeed endemic in wild chimpanzees of this region but that the circulating virus is phylogenetically distinct from all strains of HIV-1, providing direct evidence that these chimpanzees were not the source of the human AIDS pandemic.

Detection and molecular characterization of SIVcpz in chimpanzee communities in the vicinity of Kisangani should directly test the OPV/AIDS theory. An earlier survey of chimpanzees at Wanie-Rukula near Kisangani (Fig. 1a; W. D. Hamilton, M.W. and J. B. J., January 2000, see ref. 9) failed to identify SIVcpz viral (v) RNA in any of 34 faecal samples collected. However, western immunoblot analysis of 10 chimpanzee urine samples collected at the same time identified two specimens that showed strong crossreactivity with the HIV-1 core protein p24 (Fig. 1b). Such indeterminate urine antibody profiles were found in chimpanzees from Tanzania, where SIVcpz infection was subsequently demonstrated after amplification by polymerase chain reaction (PCR) and sequencing of DNA[10].

To confirm the existence of SIVcpz in the Kisangani apes and to identify circulating strain(s) at a molecular level, we resumed field-work in February 2003, this time collecting 97 faecal samples from three different sites (for map, see supplementary information). From these, we identified one SIVcpz vRNA-positive specimen from the Parisi forest by PCR amplification of *gag* (422 base pairs) and gp41/*nef* (699 base pairs) sequences. This result confirmed that natural SIVcpz infection was present in chimpanzees in the Kisangani region.

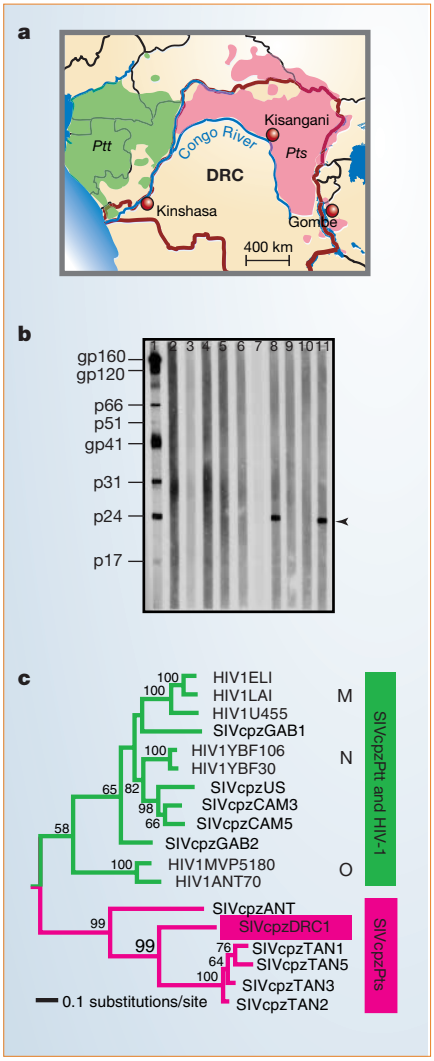

Figure 1 The Kisangani expeditions and refutation of the OPV/AIDS theory. **a,** Map of the Democratic Republic of Congo (DRC) and neighbouring countries showing the ranges of *Pan troglodytes troglodytes* (*Ptt*) and *Pan troglodytes schweinfurthii* (*Pts*). **b,** Western blot analysis of urine samples from 10 chimpanzees, collected during the 2000 expedition to rainforests near Kisangani; plasma from a positive HIV-1 control is shown in the left lane, with crossreactivity to the different viral proteins indicated. Two samples showed strong crossreactivity with HIV-1 p24 (arrowhead). **c,** Maximum-likelihood-estimated phylogenetic tree for gp41/*nef* sequence data, with bootstrap results. Bootstrap percentages are shown for all clades that were present in more than 50% of 1,000 maximum-likelihood-inferred bootstrap trees. Support for the SIVcpzDRC1/SIVcpzTAN clade was very strong (99%). Analysis of partial *gag* sequences supported the same phylogenetic position for SIVcpzDRC1 (data not shown). For further details of phylogenetic analyses, see supplementary information.

Phylogenetic analysis of the newly derived sequences revealed that the Kisangani virus clustered with high statistical support with SIVcpz strains that were infecting chimpanzees of the same subspecies (*Pan troglodytes schweinfurthii*) that lived about 800 km to the south-east in Gombe National Park in Tanzania[10,11]. The new virus, which we designate SIVcpzDRC1, represents a third lineage within the well circumscribed *P. t. schweinfurthii* SIVcpz radiation, and is clearly distinct from the *P. t. troglodytes* SIVcpz clade that includes all known strains of HIV-1 (Fig. 1c, and see supplementary information).

These results indicate that chimpanzees in the vicinity of Kisangani are endemically infected with SIVcpz that is highly divergent from HIV-1, thereby ruling out these apes as the source of HIV-1 and refuting the OPV/AIDS theory. Instead, each of the many circulating HIV-1 variants comprising groups M, N and O is linked to SIVcpz from *P. t. troglodytes* (Fig. 1c), the chimpanzee subspecies native to west-central Africa[1,12].

Given that fears about the safety of polio vaccines are currently threatening the global campaign to eradicate the disease[8], our clear-cut evidence against one of the key sources of concern is timely. The molecular epidemiological data presented here, together with data suggesting that HIV-1 group M originated 30 years before OPV trials were conducted[1,13] and the absence of detectable SIVcpz or chimpanzee DNA in archival stocks of OPV[2,3], should finally lay the OPV/AIDS theory to rest.

Michael Worobey*, Mario L. Santiago†, Brandon F. Keele†, Jean-Bosco N. Ndjango‡, Jeffrey B. Joy§, Bernard L. Labama||, Benoît D. Dhed'a‡, Andrew Rambaut¶, Paul M. Sharp#, George M. Shaw†☆, Beatrice H. Hahn†

**Department of Ecology and Evolutionary Biology, University of Arizona, Tucson, Arizona 85721, USA*
e-mail: worobey@email.arizona.edu
†Departments of Medicine and Microbiology, and ☆Howard Hughes Medical Institute, University of Alabama, Birmingham, Alabama 35294, USA
Faculties of ‡Sciences and ||Medicine, University of Kisangani, Democratic Republic of Congo
§Department of Biological Sciences, Simon Fraser University, Burnaby, British Columbia V5A 1S6, Canada
¶Department of Zoology, University of Oxford, South Parks Road, Oxford OX1 3PS, UK
#Institute of Genetics, University of Nottingham, Nottingham NG7 2UH, UK

1. Sharp, P. M. *et al. Phil. Trans. R. Soc. Lond. B* **356,** 867–876 (2001).
2. Blancou, P. *et al. Nature* **410,** 1045–1046 (2001).
3. Berry, N. *et al. Nature* **410,** 1046–1047 (2001).
4. Rambaut, A., Robertson, D. L., Pybus, O. G., Peeters, M. & Holmes, E. C. *Nature* **410,** 1047–1048 (2001).
5. Plotkin, S. A. *Phil. Trans. R. Soc. Lond. B* **356,** 815–823 (2001).
6. Hooper, E. *The River: A Journey Back to the Source of HIV and AIDS* (Penguin, London, 1999).
7. Hooper, E. *Atti Conv. Lincei* **187,** 27–230 (2003).
8. Butler, D. *Nature* **428,** 109 (2004).
9. Trivers, R. *Nature* **404,** 828 (2000).
10. Santiago, M. L. *et al. J. Virol.* **77,** 2233–2242 (2002).
11. Santiago, M. L. *et al. Science* **295,** 465 (2001).
12. Gao, F. *et al. Nature* **397,** 436–441 (1999).
13. Korber, B. *et al. Science* **288,** 1789–1796 (2000).

Supplementary information accompanies this communication on *Nature*'s website.
Competing financial interests: declared none.