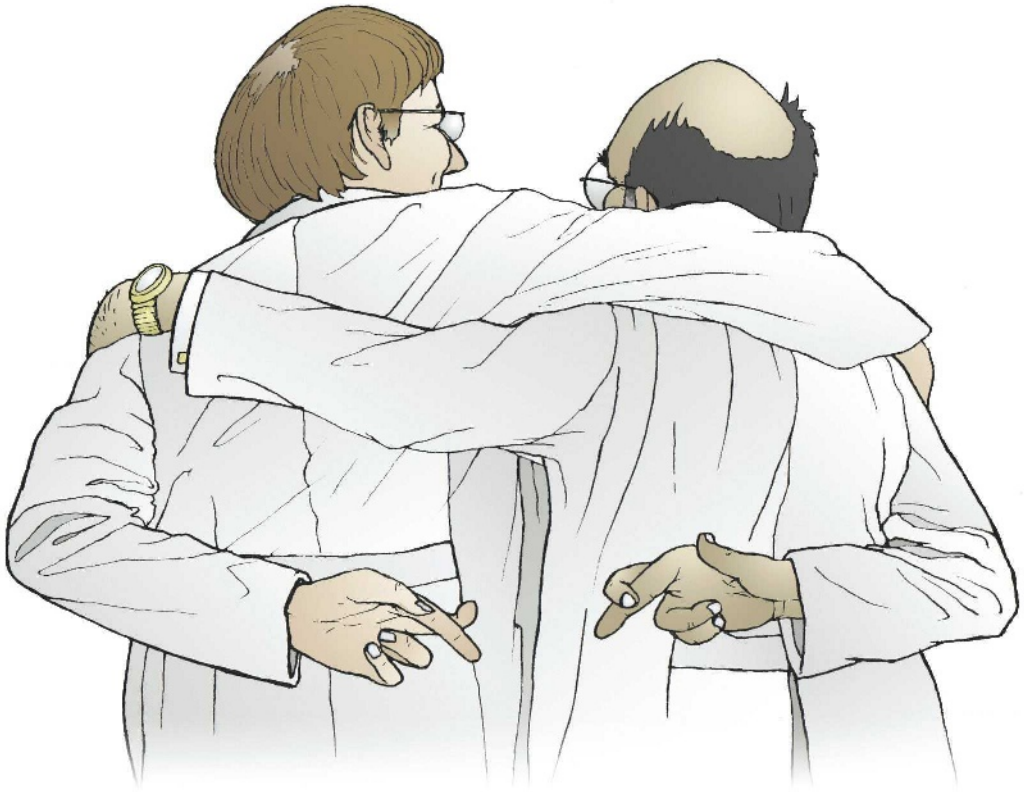

J. H. VAN DIERENDONCK

With all good intentions

Collaborations spawn fresh ideas and boost productivity — most of the time. **Heidi Ledford** examines what happens when a working relationship breaks down, and asks how to avoid it.

Break-ups can be painful, as biologist Paul Weldon and chemist Andrew Evans can attest. Weldon spent nine months and filed a lawsuit trying to retrieve a sample he had shared with Evans as part of a collaboration. And Evans estimates that the failed collaboration cost him dearly in wasted time, energy and materials.

Of course, that was by the bitter end of the relationship. At the start, two years ago, things looked a lot more promising. Weldon, a research associate at the Smithsonian Institution's National Zoological Park in Washington DC, had just isolated a compound called bovidic acid from the oily skin secretions of the gaur (*Bos frontalis*), an endangered ox. He suspected that it was the animal's natural mosquito repellant, but he needed a chemist to create a synthetic version of the molecule and confirm that he had found the right compound.

Weldon asked Evans, then at Indiana University in Bloomington to team up with him, and he sent Evans a sample of bovidic acid. The two corresponded by e-mail, and Weldon travelled to Evans's lab. Neither saw the need to formalize their relationship in writing — they had collaborated with researchers before and such measures had never felt necessary. It was a decision they would both come to regret.

The partnership slowly fizzled as the two collaborators' interests diverged. Then conflict arose over who owned the samples. "Collaborations always start off in a woolly way," says Evans, who is now at the University of Liverpool, UK, "and it either takes off and goes great or one of you goes off in another direction — and that's what happened here."

"I feel like I've been hit by a truck," Weldon says. "I'm going to be very circumspect from now on." But Evans has sent material to *Nature* suggesting that another, earlier collaboration of Weldon's, relating to bovidic acid, had also ended with disagreement between the collaborators. Weldon says that of about 30 collaborations he has entered, only those two have ended under difficult circumstances.

Teaming up

More and more researchers are entering into collaborations, often with multiple members and in distant locations. Among the top 200 research universities in the United States, science and engineering publications involving multiple institutions increased 48% between 1988 and 2001 (ref. 1). And between 1990 and 2000, the proportion of publications from international collaborations nearly doubled, accounting for close to 16% of all scientific articles published in Thomson Scientific's ISI Web of Knowledge[2]. The rise of interdisciplinary research and the ease of long-distance communication have encouraged this trend, along with funding agencies that earmark grants for collaborative projects.

Many of these collaborations are productive, generating new friendships, data and ideas. But researchers often underestimate the effort it takes to nurture a successful collaboration, or fail to anticipate the many ways one can go sour. "It is astonishing how little communication there is in the scientific community concerning planning of the project and talking about who is doing what," says Ulrike Beisiegel, an ombudsman for the German Research Foundation in Hamburg. Without such planning, and a written agreement, scientists can find themselves in testy exchanges over paper authorship and data ownership. At best, these are rocky patches that can be smoothed over; at worst, such conflicts can lead to abandoned projects, wasted research funds and lawsuits.

Weldon spent the next nine months fighting to get the bovidic-acid sample back, not because it was valuable but "out of principle", he says. Richard DiMarchi, then the chair of Indiana's chemistry department, urged Weldon and his collaborator to work it out.

Weldon hired a lawyer and, last September, sued Indiana University for possession of all bovidic-acid samples related to the

collaboration. Because the bovidic acid had been purified at Indiana University, the university felt that it could have a claim to ownership, says Beth Cate, associate general counsel of the university. But "in the end we decided it would be best to be done with this matter", she says. "I think there were some misunderstandings here that led to some heightened distrust or emotion." Two months after Weldon filed the lawsuit, the university told him that they would return the sample, and he dropped his claim.

This whole story runs counter to the idea that scientific collaborations are advantageous. In a 2006 analysis of publications, pharmacologist William Figg at the National Cancer Institute in Bethesda, Maryland, showed that the number of citations earned by biomedical articles in elite journals rises with the number of authors on the publication[3]. Another study found that biotechnology papers with at least one international co-author tend to have a higher citation rate than those with a national co-author at a different institution[4]. University administrators and funding bodies sometimes use such studies to promote the virtues of collaboration in the hope of increasing the impact of the research they pay for. Some funding agencies, including the US National Science Foundation (NSF) and the European Commission, have set aside money specifically for interdisciplinary or international collaborations. The European Commission's Seventh Framework Programme, for example, has set aside €32.4 billion ($51 billion) for international collaborative research projects.

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"There are unintended consequences when large funding agencies force people to collaborate."
— Jonathon Cummings

But Jonathon Cummings, professor of management at Duke University in Durham, North Carolina, questions whether this type of forced collaboration is as productive as the figures initially suggest. "There are unintended consequences when large funding agencies force people to collaborate," he says. "If you say we're not going to give you money unless you bring in two to three other universities, it's forcing their hand." Some sociologists have pointed out that it is inaccurate to measure the success of collaborations by counting up publications and then seeing how many stemmed from teams. It overlooks those collaborations that collapsed before papers were written and therefore skews the data towards successful efforts.

In an attempt to reduce this bias, last year Cummings and his colleagues surveyed participants in 491 NSF-funded research collaborations, more than half of which spanned multiple universities. They collected data on all the projects that were funded — including less successful collaborations — and measured what they produced in terms of 'knowledge outcomes', such as patent applications, conference presentations or published articles. The study suggested that projects involving multiple universities produced fewer knowledge outcomes than those involving a single institution[5]. Cummings says that this is because some of the collaborators failed to plan sufficiently for the challenges of coordinating research across the disciplinary and geographical boundaries, so they either wasted time and effort or their collaborations broke down. "When you come together in an attempt to get money but don't really think through how you're going to work together, it ends up backfiring in terms of lower outputs and lower productivity," he says.

Scientists have a rosier view. They often compare their collaborations to romantic relationships and, like true romantics, they feel that these relationships are built on trust. They prize the ability to form spontaneous, unstructured liaisons — ones that spring from chance encounters at a meeting or coffee room — and enjoy the flush of generating new ideas with like-minded colleagues. "Entering collaborations is much like dating," says Neil Smalheiser, a neuroscientist at the University of Illinois, Chicago, who co-founded the *Journal of Biomedical Discovery and Collaboration*. "Some people obsess over it, whereas some proceed blithely and blindly without considering long-term ramifications at all."

The consequences of a failed collaboration cut just as deeply as a failed affair. The most common source of conflict is over publications, which are often the first time that anything is written down. This can raise a host of thorny questions about when data are ready for publication and — the point on which careers are made or broken — who should be on the author list and in what order. The US Office of Research Integrity in Rockville, Maryland, has reported that it receives many misconduct allegations about researchers who have published some aspect of a joint project without crediting a former collaborator, but that these cases are not within its remit. Academic institutions are left to decide whether to launch investigations.

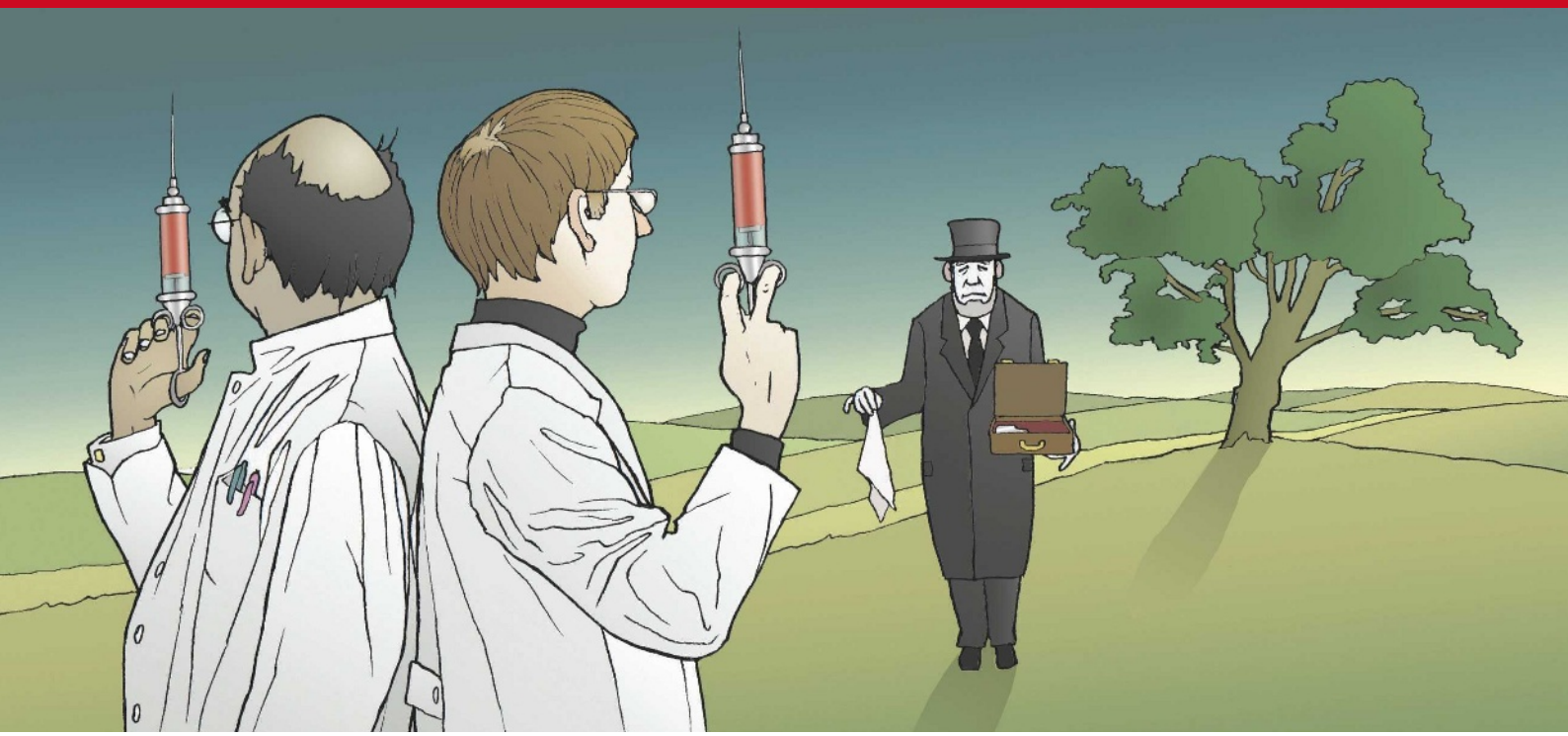
Data ownership is another common source of disagreement, particularly when valuable intellectual property is discovered as part of the work. "People and institutions can get greedy," says Diane Sonnenwald, a sociologist at the University of Gothenburg in Sweden who has studied scientific collaborations. "Research has shown that it's easiest to address these issues before there's real intellectual property to argue over". Beisiegel says that she advises scientists to resort to a lawsuit if a collaborator has threatened their intellectual property. But some researchers shy away from such battles. "It's always a question of how much time and energy you want to spend on these things," says Wesley Shrum, a sociologist at Louisiana State University in Baton Rouge. "Some battles are worth fighting, and some are not."

Write it down

Among those who study collaborations, the solution is clear: potential partners should get everything in writing at the start. Written 'pre-collaboration agreements' can spell out division of labour, data ownership and who will be on the author list. They are sometimes dubbed 'collaboration prenuptials' or 'prenups' in reference to the legal documents that some couples sign before getting married, delineating how property and wealth will be split in the event of a divorce. But many scientists baulk at the idea of a prenup, saying that it can be awkward to press a new collaborator into a written contract before materials and ideas are exchanged, and before knowing where the research will lead. "We recognize that using scientific prenuptials goes against the informal norms of science," wrote Howard Gadlin, ombudsman for the US National Institutes of Health in a 2002 article on responsible research conduct[6]. "But we have seen the damage that can be caused, both scientifically and personally, when scientists at the NIH overlook questions such as these in their enthusiasm to launch an intellectually exciting collaboration."

"I'm going to be very circumspect from now on."
— Paul Weldon

Participants in large, formal collaborations often use their grant applications as a form of prenup, because it forces them to decide precisely who will do what. Many universities have template agreements for researchers to use before establishing a collaboration with industry, but such agreements are not required and often not even encouraged for collaborations



J. H. VAN DIERENDONCK

within academia. "We don't see a lot of those at all," says Peggy Fischer, associate inspector general for misconduct investigations at the NSF. "Maybe we don't see them because they work, and maybe we don't see them because they don't exist."

A rough outline

Smalheiser argues that written prenups are not always necessary, particularly when collaborations are with people one already knows and trusts. "I don't see formal agreements as something practical to pursue," he says. "Especially because the nature of the research and the nature of the collaboration may be continually evolving." He has developed a checklist of issues to hash out early in the collaboration, such as authorship and data sharing[7]. The checklist is intended to raise important issues for discussion up front and, although it can be used as the basis for a prenup, it does not have to yield a formal agreement, Smalheiser notes. Even sketching out a rough outline of the collaboration can be useful, and updating the agreement as conditions of the collaboration change (see 'The collaborators' prenup').

Long-distance relationships can be particularly testing, in science as in romance. As a general rule, the further away a collaborator is, both in discipline and in geography, the more prone the collaboration is to conflict, says John Walsh, a sociologist at the Georgia Institute of Technology in Atlanta. Researchers at different institutions are more likely to face conflicts over schedules, for example, and disciplines may have differing customs for authorship. "There is pressure now both to have larger collaborations and to have remote collaborations that incorporate resources from different places," says Walsh. "You're more likely to be faced with difficulties that you wouldn't face with a local team of modest size." Sorting through the wreckage of a crumbled international collaboration can be complicated by conflicting international policies and laws (see Commentary, page 686). "When you were collaborating with somebody down the road or in the state next door, everybody was operating by the same rules," says Nicholas Steneck, director of the Research Ethics and Integrity Program at the University of Michigan in Ann Arbor. "Now all of a sudden you've got collaborations with labs around the world, and there aren't the same rules and understanding."

The key, says Cummings, is not to break up collaborations but to allow more time and money for management. This might involve hiring staff to help coordinate the programme. In response to his study, the NSF began requesting management plans (which are effectively compulsory prenups) in some of their programmes, particularly interdisciplinary ones. "They've realized that it's one thing to write a proposal for some grand idea," says Cummings. "It's another to spell out who's going to do what and how you're going to do it." The European Commission also requires management plans to accompany its Seventh Framework Programme funding for collaborative projects. But "it's still not a common occurrence across all funding agencies," Cummings says.

Paul Jeffrey of Cranfield University, UK, suggests that funding agencies could also boost collaborative productivity by promoting long-term collaborations, rather than favouring new partnerships. "You can't lock two strangers in the room and expect them to get along, and you can't do that with scientists either," he says. "The overhead of setting up a productive relationship is very high."

Weldon and Evans's overheads were certainly steep. In the battle over bovidic acid they lost time, money and, perhaps most importantly, trust. Weldon now has the bovidic-acid sample back. And although Evans says the sample is intact, Weldon says he is still a little nervous about opening it up and wants to wait until a colleague is present. "I know it may sound a little paranoid," says Weldon. "After all of this, I just want to be careful." So does Evans. Next time, he says, "I'd do everything by the book. You must get the relevant documentation, it's absolutely imperative". ■

The collaborators' prenup

Ten questions to discuss before starting a collaboration.

- What do we expect to get out of this?
- Who is going to do what and by when?
- Who will have access to our data?
- Who will give public presentations, and how much data will they reveal?
- How will we assign authorship?
- How will we decide when to publish?
- Who owns the intellectual property?
- Will we share our reagents with other labs?
- What happens if one of us leaves the project?
- What happens if one of us wants to form a separate, but related, collaboration with another lab?

Adapted from: NIH Office of Ombudsman

Heidi Ledford writes for *Nature* from Cambridge, Massachusetts.

1. www.nsf.gov/statistics/nsf07320/
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3. Figg, W. D. *et al. Pharmacother.* **26,** 759–767 (2006).
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7. Smalheiser, N., Perkins, G. A. & Jones, S. *PLoS Biol.* **3,** e217 (2005).

See Editorial, page 665.