Lab hands and knowing toxic substances in Uganda

SANDRA CALKINS
Sandra Calkins is Assistant Professor of Social and Cultural Anthropology at Freie Universität Berlin. Her email is s.calkins@fu-berlin.de.

Alfred Gilman, the famed US Nobel-prize winning biochemist, was not afraid of ethidium bromide. He is said to have liked to dip his bare hands into the chemical solution, take out the stained agarose gel and bite off a piece and swallow it, just to demonstrate to scientists at his lab that the irrational fear of this substance was unfounded. A senior researcher, who had just returned from the Danforth Plant Science Center in the US told this anecdote during one of my visits to the Ugandan National Agricultural Research Laboratories at Kawanda. Molecular biologists around me responded with horror and disbelief.

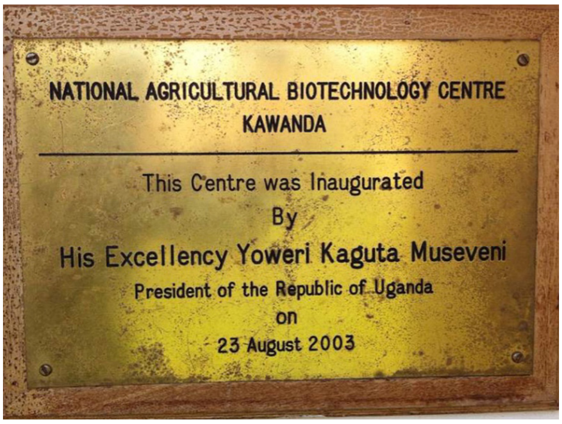
While many chemists don't consider ethidium bromide to be particularly hazardous, molecular biologists at Kawanda who regularly work with it feel differently: it is one of the most fear-inspiring chemicals. Ethidium bromide is a fluorescent substance used in molecular biology laboratories to stain and make visible the DNA bands of experimental plants in agarose gels. This procedure is central to proving the existence of a newly inserted gene in a plant organism.

In the Ugandan lab where I did fieldwork on the development of a micronutrient-enriched genetically modified banana plant, it is both used and feared because of its ability to slip between and bind with the double-stranded DNA bands. It is considered a potent mutagenic and a highly carcinogenic chemical – a leaky substance that could potentially seep in between researchers' DNA bands too, setting off several unwanted, long-term mutations. Cancer, in short, is what these biologists usually associate it with.

Different scientific disciplines know and handle chemical substances differently, leading to vastly divergent assessments, such as Gilman's and that of the molecular biologists I worked with in Uganda. There are different ways of knowing toxic substances. For these molecular biologists, the chemicals they use are merely a means to an end and, working for a national research institute, they focus more on developing products (e.g. disease-resistant or nutrient-dense crops) that Ugandan farmers can use to improve their yields. My suggestion is that they get to know toxic substances in what may seem to be a slightly paradoxical way for scientists: namely, not mainly through formal knowledge about a substance's chemical pathways but rather through proximity and everyday contact with them. For Ugandan molecular biologists, this 'contact' did not normally involve dipping their bare hands into the ethidium bromide pool and eating the gel but rather knowing where and how to touch it safely, as well as where not to place one's hands.

The poisons of place

And place is part of poison here. Danger doesn't only emanate from the chemical itself but also from an uncertain, hard-to-control lab setting in Uganda. The Kawanda lab is not an internationally certified lab, and many of its senior staff consider working there today outright dangerous. Safety procedures for lab work are in place in principle but remain hard to monitor and implement. This has to do with the material set-up at Kawanda. The lab infrastructure was initially up-to-date and well equipped by the British colonizers for their research on 'colonial primary products', such as tea, coffee and cotton. It later became integral to nationalist dreams of progress and self-determination on independence but then went mostly underfunded and mismanaged in the subsequent decades.



SANDRA CALKINS

SANDRA CALKINS

Fig. 1. *Sign at the entrance to the biotech lab, July 2017.*
Fig. 2. *Two researchers preparing samples in the biotech lab, September 2017.*

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Fig. 3. *Dr Tindamanyire handling research materials, August 2017.*
Fig. 4. *Door to the darkroom, August 2015.*

SANDRA CALKINS

SANDRA CALKINS

Research work came to a near-complete halt in the 1970s under Idi Amin and did not flourish much in the 1980s due to structural adjustment policies. Since the early 1990s, short-term and narrow collaborative research projects with organizations from the Global North have proliferated; however, mostly these bring project-specific technologies without investing in the maintenance of basic infrastructure at Kawanda. The lab infrastructures at Kawanda today form a highly unstable palimpsest with new project-funded technologies and devices running on unstable power lines, chronically short of necessary lab supplies and fraying pipes and cables only being partially repaired (see Calkins forthcoming; cf Geissler et al. 2016 and Tousignant 2013 for histories of other sites of African science).

What adds to this hard-to-control lab setting is a steady yet changing flow of fresh university graduates, interns and short-term project staff. The National Agricultural Research Laboratories at Kawanda, like other research institutes of the National Agricultural Research Organisation directly under the Ugandan Ministry of Agriculture, are key training sites where unremunerated students from Ugandan universities' biotech and biology BA and MA programmes gain hands-on experience in their field as 'volunteers' by applying themselves to current agricultural problems, like viral or bacterial diseases, fungi, pests or other issues Ugandan farmers are facing. To avoid hazards and accidents but also as a measure of quality control, experienced researchers usually make sure to brief and meticulously train at least those volunteers supporting their own research projects. This tendency to train students made it easy for me, an anthropologist without previous lab experience, to observe how researchers were in contact with and taught others to approach ethidium bromide.

Learning to handle a toxic chemical

In July 2017, Dr Tindamanyire, a postdoc with an Australian PhD who goes by the name 'Jimmy' but is more often referred to as 'Dr Tinda', taught two of his young research assistants and myself how to do Southern blotting, a procedure used to confirm the presence of an inserted sequence of DNA in an organism. His instructions begin even before we enter the lab room from the hallway: he demonstrates how to open the lab doors safely by pressing his elbows against the glass in the doors to avoid touching the door handles. 'You never know where other people's hands have been', he explains. Before we start to work at a bench considered contaminated by ethidium bromide, he instructs us not to touch any surfaces even though we are wearing gloves, not to lean against desks with our lab coats, and, evidently a careful observer, he turns to me and tells me not to put my notebook or my cell phone down on any surface.

At a later stage during the procedure, Dr Tindamanyire briefs us on entering the darkroom next door, a room with restricted access, we learn. All of us had been there many times without any such briefing, not least because the liquid nitrogen that we regularly used for other routine tasks is stored in large flasks there. Dr Tindamanyire must be aware of that? We look at each other but remain silent. He then searches us with his eyes, inspecting our lab coats and shoes. His gaze lingers on Gloria's painted pink toenails, which are peeping out of her blue sandals. She apologizes in embarrassment that she forgot to bring her closed lab shoes from home today. Dr Tindamanyire sighs in frustration and tells Gloria not to come near the bench with the ethidium bromide.

Turning to me, he complains about the low standards of 'African science'; in a 'normal' lab, he would have to send her home. By referring to a 'normal lab', he meant a properly certified lab that works according to its safety protocols, like the one at Queensland University of Technology in Australia where he did his PhD. But here at Kawanda, they were often forced to practice 'African science', not normal science (see Droney 2014). For Dr Tindamanyire, 'African science' meant an insufficient, make-do scientific practice that involves improvising solutions to resource shortages and other failings of infrastructure. This type of science also implies dealing with often hazardous human negligence and the misuse of lab equipment that results from too little training.

A bit later, as we enter the darkroom, he tells me to cross my arms, my notebook under them, so I won't be tempted to touch anything. Gloria, who remains at the back of the room, folds her arms too and Samuel, a young lab assistant, sticks his hands into his lab coat's pockets. To mitigate his own risk of exposure, Dr Tindamanyire has developed a choreographed routine that prevents him from inadvertently touching surfaces that could be contaminated with ethidium bromide. We stand back and observe his movements, which seem like a dance. He holds his left and right hand far apart. He prepares to use his left hand to do the dirty work, in line with cultural conventions in Uganda, while tucking his right hand under his lab coat and into the back pocket of his jeans.

Dr Tindamanyire prepares a surface to work on in the darkroom. With his left hand he picks up a square plastic container with a rusty orange liquid, the dissolved ethidium bromide powder, and places it on the bench. He then looks for other containers he needs for washing and applying the photo fixer that he left on the floor last time he worked here, before he realizes that one of them has gone missing. Dr Tindamanyire is a practicing Pentecostal, known at the lab for his work ethic and his mild temperament, so we are surprised as he curses. 'Someone took the bowl and is endangering the whole lab!', he cries in consternation. This someone, we learn, has no clue that ethidium bromide always drips on the floor in the darkroom, then is mopped around the floor by the lab cleaner, and sticks to the bottom of the container. 'Nothing is allowed to leave this room!', he exclaims, his face in concerned furrows:

> They just carry it around to move their media and stuff from bench to bench with it. They don't know they are carrying the ethidium bromide around with it and smear it everywhere. That's why the sign at the door says no unauthorized access!

He strips off his gloves, leaves the three of us alone in the darkroom and storms outside to search for the container. After a few minutes, he returns with a container, unsure it was the one that was removed, and a permanent pen. He writes on the container: 'EtBr room – DO NOT REMOVE.'

SANDRA CALKINS

SANDRA CALKINS

SANDRA CALKINS

Fig. 5. *Dr Tindamanyire in the darkroom, August 2017.*
Fig. 6. *Gel documentation centre outside the darkroom, August 2015.*
Fig. 7. *Researchers waiting for a procedure to finish, August 2017.*

Dr Tindamanyire soaks his agarose gel in the ethidium bromide for about 15 minutes, then scoops it out with a ladle and carries it into the room outside to a small cabinet next to a computer and keyboard to expose it to UV light and takes a photo, all the while only using his left hand for these tasks. Then, extending his left hand with the glove that had scooped the gel from the ethidium bromide container into the air, he uses his right hand to enter data into the keyboard. After he finishes, he uses the ladle and carries his gel back into the darkroom to dispose of it, again carefully using only his left hand for anything contaminated with this chemical. His hands only relax after having stripped off his gloves.

After leaving the darkroom, we all felt irritation in our eyes, noses, throats and mouths from inhaling the toxic vapours. Dr Tindamanyire was the first to complain, and Samuel, Gloria and I affirmed we felt the same itching and scratching sensations. We were relieved we had finished this part of the protocol. Dr Tindamanyire told us that not everyone shared this concern about ethidium bromide. The other day he had watched a student extract a gel from the ethidium bromide pool with his bare hands. Unlike Gilman, who used touching and biting to demonstrate knowledge, control and mastery over chemicals, this story was used to invoke danger and chaos. It underlined the fact that the lab space at Kawanda was hard to control where people unwittingly expose themselves to toxic chemicals. Samuel and Gloria looked disgusted and shook their heads in disbelief. Samuel later told me how much he hated the darkroom at Kawanda; it made him feel dizzy and gave him a headache when he stayed there for a longer period. While Gloria still did not always bring her lab shoes, I overheard her cautioning new volunteers on the dangers of ethidium bromide contamination. This training session made them more cautious in and around the darkroom.

What hands know

Dr Tindamanyire is often frustrated about what he takes to be the carelessness of fellow researchers, some of whom are not adequately trained and grossly underestimate the dangers lurking in this contaminated lab. But he is equally mad about the predicament of having to practice science in a materially unstable lab environment and often enough himself having to produce makeshift solutions. That makes him more diligent in training young project staff to avoid dangerous exposure at this lab. Researchers like Dr Tindamanyire and those he trained learn about hazardous substances by handling them with care, developing and habituating themselves through skilled movements of hands and bodies that avoid unnecessary contamination. For these molecular biologists, knowing a toxic substance thus is not mainly about an abstract, bookish-type of knowledge of a substance's chemical properties and reaction chains, but rather about devising safe, practical routines of handling.

Research practices in biology involve dexterity. In a different setting, Natasha Myers (2015: 79-80) wrote about the interlocking of haptics and visuality in the scientific practices of protein crystallographers in the US. These biologists teach their students to 'see' the three-dimensional protein structures of their models by letting them actively handle them. While this situation differs markedly from what Ugandan biologists deal with, they similarly stress the importance of skilfully putting one's hands to use. At this Ugandan lab, when molecular biologists speak about someone's ability to 'handle' something, it denotes a manual competence, a right and safe way of touching or manipulating things that produce results in a materially unstable research environment. Instability here means a dangerous research environment where due to a lack of training and a scarcity of all things, including even simple

SANDRA CALKINS

Fig. 8. *Dr Tindamanyire at the end of a lengthy procedure, August 2017.*

plastic containers, one always has to reckon with unwitting contamination. Competent handling at Kawanda thus encompasses both knowing how to handle experimental objects and potentially toxic chemicals correctly as well as being aware of potential hazards that could result from material decay and others' negligence.

While the danger of contamination is more pronounced at Kawanda than at comparable biotech labs in the Global North, Ugandan biologists' understanding of competent handling is still in line with how molecular biology is practiced elsewhere too.

Unlike high-energy physics, which seeks to figure out causal principles and understanding the larger picture, the epistemic culture of molecular biology aims at producing reproducible results and at putting to use laboratory equipment and protocols that outline a correct sequence of steps to be taken (Knorr-Cetina 1999). Unlike botany or zoology, molecular biology thereby typically mistrusts the researcher's sensing body and replaces it as a primary research tool with an arsenal of devices, machines and experimental set-ups that produce standardized measurements of the natural world. However, despite this backgrounding of the sensory, molecular biology is known to be a practical and overwhelmingly manual workmanship on lab benches, relying on scientists' dexterity and ideally their 'golden touch' (ibid. 96).

Park Doing's (2004) ethnography of scientists and lab technicians in a US lab likewise foreground tactile skills and abilities, what his interlocutors called 'lab hands'. While scientists imagine technicians to be endowed with an innate quality, a naturalized and intuitive touch that enable them to sense and troubleshoot errors in equipment, technicians believe this view dismissed their abilities: being and having a good 'lab hand', according to them, hinges on hard-won knowledge and years of experience. This understanding of a lab hand that is gradually acquired on the job resonates with how many Ugandan biologists schooled their hands to be skilled and competent by performing tasks in the Kawanda lab. This is also how they get to know toxic substances, namely, through every day and routinized contact with them.

The skilled choreography that Dr Tindamanyire performed; training young scientists in handling lab equipment; speaking about moments of physical discomfort and sharing stories about the mishandling of devices and chemicals: all of this contributed to learning, knowing and understanding the toxic nature and dangers posed by specific substances they encountered in their everyday lab work in both memorable and visceral ways. Handling encompasses a type of practical knowledge that is often ignored in formal disciplinary accounts and is informally passed on, like in Dr Tindamanyire's training session, but still is central to the actual work being done and to do it safely. This type of practical and context-specific knowledge is particularly important in settings like Kawanda, where research infrastructures are not well-maintained, everyday work materials are often lacking, and students with little training share workspaces.

Science as an endeavour is progress and outcome-oriented. However, sometimes we overlook the way scientists informally learn how to manage their sensory engagements with their research materials. Molecular biology as a discipline places much emphasis on standardized protocols that allow reproducing results in any lab with the same equipment, but it tends to mute and background a layer of everyday menial and practical work – 'the lab hands' that are central to producing results.

Drawing attention to what hands do might be a strange choice for thinking about knowing specific chemicals. And yet, locating knowing in how skilled lab hands move tells us more about the properties, dangers and uncertainties associated with various substances than merely consulting state-of-the-art biochemistry textbooks. It also tells us how being in contact with such substances, textures everyday professional routines and understandings of a place.

Being in contact with toxic substances is central to the experience of working at Kawanda and to understanding this lab as a site of African science, which, unlike the 'normal lab', is additionally marked by the constant possibility of unwitting dangerous exposure. Touch and close contact can convey a more profound sense of the type of substance one is encountering than merely studying abstract knowledge and facts. This was something that the brilliant Alfred Gilman intuitively understood, at least if the anecdote I mentioned at the outset is true. Sadly, he died in 2015 of pancreatic cancer (Grimes 2015). ●

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