Laboratory Life

Most fieldwork was rendered impossible in 2020, but our research continued, either despite or because of the events that disrupted our lives. In this section of *Backdirt*, some of this work is briefly presented.

Archaeology and the Impermanence of Scientific Knowledge[1]

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For me, Stephen Acabado, it is now the 107th day of the stay-at-home order in Los Angeles. This means more video games than usual for my kids, while my wife and I work from home. One of the games that my 14-year-old son plays is Civilization 6, a more or less historical take on empire building and cultural development. Because I am an archaeologist, my son often asks me about themes in the game. Last night he asked how archaeologists know what they know and if we ever change our perspectives if new information arises. So the question was about knowledge production, data analysis, and changing perspectives; all because of Civilization 6.

In the age of Covid-19, science and data have been thrust into the limelight as they guide our government officials and as university administrators make decisions to mitigate the effects of the pandemic. There is, however, a common misunderstanding about the nature of science: that science seeks the truth. Questions regarding truth have been around for thousands of years, and people do use the scientific method to seek the truth, but we now know that scientific knowledge is only as good as the data that support it. We know that science is inherently corrigible or open-ended and can always be corrected or revised.

Science does not really provide an answer to the question of what is the truth. It gives us tools to understand observable and even intangible phenomena, but it never aims to commit to offer the truth; particularly not the absolute kind. Rather, it tests hypotheses, which, if supported, become the best explanation—a tentative truth—until they are refuted by a new model or set of data. So science is a method for asking and answering questions that relies on data, testability, and replicability.

As an example, our current theory of evolution is no longer Charles Darwin's theory of evolution by natural selection; it is now the synthetic theory of evolution. Darwin's model was not able to explain trait inheritance. It was only after the discovery of Gregor Mendel's publications on pea plants that Darwin's theory became viable. The synthetic theory of evolution emerged in the 1930s and incorporates genetic inheritance into Darwinian evolution.

Thus, science is dependent on data. Without data to support them, explanations are just anecdotal, or hearsay in legal speak. Covid-19 has once again exposed us to the nature of science. In the absence of data, or the rejection of data, Covid-19 has been dismissed as similar to influenza and no big deal. Even though history has given us fair warning about pandemics, particularly the 1918–1919 Spanish Flu (which was first documented in the United States), misunderstanding or sheer ignorance of how science works has contributed to the unabated spread of the virus, particularly among vulnerable populations around the world. For now, there is much we do not know about Covid-19. Scientists are working around the clock to help us understand the disease by gathering data, developing hypotheses, and running experiments. That is science. It includes observation,

1. A shorter version of this article appeared on Rappler, an online news website in the Philippines. Stephen Acabado, "Bakit Walang Forever? The Impermanence of Scientific Knowledge," Rappler, July 2, 2020, https://rappler.com/voices/ispeak/opinion-impermanence-science-archeology (accessed August 31, 2020).

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3. Save the Ifugao Terraces Movement.

Figure 1. The Batad rice terraces in Ifugao, Philippines.

hypothesis, testing that hypothesis, and then providing explanations. Without this process (the scientific method), elucidations are just anecdotal thoughts.

We recently wrote about the dominant narrative of the 2,000-year-old origin of the Ifugao rice terraces in the Philippines and the waves of migration theory (Beyer 1948). These are examples of anecdotal modeling; they are not testable or replicable. To argue for the inception of the terraces, you need data to develop a model. Our dating of the Ifugao rice terraces is based on this process: develop a testable model, support or disprove the hypothesis with tangible contextual data, and link it with prior explanations. We started by looking for support for the idea that the terraces are indeed at least 2,000 years old, but after assessing 60 years of work, from Harold Conklin (1980) to Robert Maher (1973, 1984, 1985), and Connie Bodner (1986), to our ongoing Ifugao Archaeological Project (Figure 2), no data or evidence to support the long-history model has been produced.

The model is not based on any archaeological or scientific evidence. Nonetheless, the idea has become engrained in the national consciousness because of how history is taught in Philippine basic education. Connie Bodner (1986), working in another region in the Cordillera (Bontoc), strongly argued, based on tangible archaeological datasets, for the later inception (about 400 years ago) of wet-rice cultivation in the region.

Recent discoveries of evidence of early hominid presence on the Philippines—in Callao Cave in Cagayan and Rizal in Kalinga—also correspond to rigorous scientific reasoning. Researchers analyzed multiples datasets to explain the data recovered from these two sites. In the case of Callao, detailed analysis of skeletal morphology suggested an early hominid form. The identification of stone tool cut marks on rhinoceros bones from Rizal suggests the presence of hominins in Luzon as early as 700,000 years ago. Clearly these new datasets offer fresh information that changes our ideas about when and how humans arrived in the Philippines. We should be prepared to abandon what we think we know, or what was taught to us, in light of this type of evidence.

Covid-19 has exposed us to the nature of science.

Back to the science of dating the rice terraces. The archaeological dating of agricultural terraces requires multiple lines of evidence to develop a robust model that will establish an inception date and subsequent expansion of terrace systems. We do not just look for samples (charcoal or any organic remains) that we can date by radiocarbon analysis. We have to establish the context of each sample (including its location and stratigraphic relationships to other samples) to determine its relative age and probable utility. We record this contextual information because archaeological excavation is destructive by nature. That is why we dig as slowly and carefully as we can. We need to observe and record any changes in soil layers, their con-

stituents, and the finds we uncover. This contextual record, in the form of maps, images, and field notes, is at the basis of most of our reports. Reviewing such documents and maintaining the collected finds and samples make archaeological research replicable; it is a methodology that provides you with data. How you interpret that data is the larger part of science. Data do not speak for themselves; scientific rigor does, and scientists are committed to scientific rigor.

As an example, we reported the existence of about 50 archaeological radiocarbon dates from the Cordillera (Acabado et al. 2019). Radiocarbon analysis does not date a historical or archaeological event; rather, it dates when an organism died and when that specimen became incorporated into the archaeological record. Thus, archaeological work must be meticulous to preserve the context of the specimen being dated. The result of radiocarbon dating in a contextual vacuum is invalid. So for us to use radiocarbon dates, we have to explain the circumstances of when, where, what, how, and potentially why that sample was used as a specimen for dating. In our case, the more than 50 radiocarbon dates from Kiangan, Banaue, Hapao, Burnay, Nabyun, Poitan, Lugu, Banghallan, Bintacan, and Bontoc did not support the hypothesis that wet rice was being cultivated in the region 2,000 years ago.

Modeling from contemporary terrace constructions also gives us a glimpse of the speed with which the terraces expanded in the region. Take, for example, the amphitheater-shaped Batad terraces (Figure 1). Spatial and energetic modeling (a combination of number of workers, number of days, earth moved, and stone wall preparation and construction) by Jared Koller suggests that the Batad terraces could have been constructed within 180 years by 4.5 persons working 7.5 hours a day, six days a week (Acabado et al. 2019:12–17). Of course, more than 4.5 terrace builders would have been working in Batad. These numbers are the average of work/energetics data collected from two terrace constructions in Bolar and at the Ifugao Indigenous Peoples Education Center in Kiangan.

Science reflects truth as we know it for now.

This scientific experiment suggests rapid construction and subsequent expansion of the systems and supports the idea that the people who constructed the terraces had the complex sociopolitical organization suitable for wet-rice cultivation. Ethnographic studies suggest that wet-rice cultivation requires a specific form of social organization, even when compared to other intensified systems (such as millet, wheat, and taro production systems).

The results of radiocarbon and spatial analyses are supported by archaeobotanical datasets. There is a total absence of evidence of wet-rice cultivation in the region dating earlier than the 1600s. We are cognizant of the old adage that absence of evidence is not evidence of absence; however, any archaeological evidence that would support the 2,000-year-old origin theory for the Ifugao terraces has remained completely absent from the five major sites (Old Kiyyangan Village, Hapao, Nagacadan, Batad, and Banaue) and has arguably been discredited by the most recent archaeological and ethnographic data.

More importantly, community memory appears to support the scientific datasets. Time reckoning and genealogical reconstruction are valuable tools in understanding the Ifugao, since time reckoning is by generation and not by years. There are two examples of this narrative. The first concerns the origins of the Batad rice terraces, one of the five UNESCO recognized clusters. The story goes that the Batad hillside was discovered by brothers from Cambulo (a village close to Batad) while they were hunting. One of the brothers started a swidden field and subsequently brought his family to Batad. The terraces were constructed soon thereafter. This origin narrative presumably occurred within the last six generations.

The second is the community story in Tokak Village, in Namal, Asipulo. The Tokak community story revolves around Spanish pressure: village elders mention that their ancestors left Amduntog (a village closer to the town center of Asipulo) and resettled in Tokak (an interior village) to avoid Spanish expeditions. Their descendants returned to Amduntog after the Spaniards left. To say that oral history is not a

Figure 2. A buried irrigation ditch (*alak*) at the Old Kiyyangan Village site, excavated by the Ifugao Archaeological Project in 2012.

valid source of data is a serious misunderstanding of ethnographic methods and is disrespectful to Ifugao community stories and heritage.

So, for now, the modeling and interpretation of the archaeological data from the Cordillera are the closest we can get to the truth. Unless new data refute the model, it stands as the most plausible explanation. Practitioners of science do not feel sad when their models are disproven. It means that their experiments were not replicable or that new data have arisen. It means that scientists need to address the failures of the model, and reanalyze and reinterpret the available data to get close to the reality we perceive. But there has to be an alternative model to disprove an existing one. Countervailing evidence without a model to support is not very useful in advancing knowledge.

For Covid-19, there is still a lot we do not know about the disease, but that does not mean scientists are wrong. Every bit of new information gives hope that we will gather enough data to develop ways to eventually defeat the virus. But for now, we know we should all wear masks, avoid crowds, wash our hands, and listen to the science as it develops. Even if there is no forever truth in science, it reflects truth as we know it, for now. And people should understand what they are sharing online, because scientific data can be misused by politicians, the media, or laypeople who are only too happy to provide evidence of how right they think they are. We should understand the "principled modesty" informing science when they brandish supposedly scientific information.

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