2 PREPARING COMMUNITIES

One volunteer's interaction with a staff preparator about a particular fossil demonstrates the combination of technical and social knowledge transmitted between research workers on a daily basis. Ted, a volunteer at the Northern Museum, was preparing a dinosaur vertebra that unexpectedly had another fossil, an ossified tendon, preserved against it. He postponed removing the tendon because he feared the process would damage the vertebra. He consulted Amanda, a staff preparator, several times about this specimen, including how to support the crumbling bone (her answer: with water-soluble wax and B-72, a conservation-grade adhesive) and how much matrix to leave on the fossil. Their conversations define proper techniques as well as the hierarchy of staff preparators as decision makers and volunteers as instruction followers.

Sometimes Amanda checked on Ted, and sometimes he sought her out for help. For example, once as Amanda walked past Ted hunched over the vertebra in the lab, she asked, "How's your specimen?" "Coming along," Ted answered, without looking up. His response and body language suggested he didn't want to be interrupted. Amanda ignored these cues, subtly asserting her power as a staff member over a volunteer, and examined the vertebra over his shoulder. "Oh yeah, that is very nicely coming along," she said encouragingly. Positive feedback is just as important as criticism in any training process so as to allow novices to learn the characteristics of "good" work as well as "bad." After one discussion with Amanda, Ted said to me, "I learned a new word: centrum," the scientific name for a vertebra's

doughnut-shaped part. Alongside instruction in techniques and language, Ted was learning the lab's division of labor and social hierarchy. When I asked him whether the tendon or the "vert" was the more important specimen, he shrugged, "Don't ask me, ask [Amanda]." As a volunteer, Ted is not expected to judge the scientific value of fossils; that is a task for staff. Likewise, when I asked Ted who decides which volunteers work in which of the museum's two labs, he said, "the boss," meaning Amanda. When Ted explained preparation work to me, he detailed the goals of removing matrix and repairing breaks, but was at a loss regarding what happens when those tasks—his tasks—are finished: "Then [Amanda] does whatever she does," somehow transforming the specimen into part of the museum's collection. The responsibilities and hierarchy of staff and volunteers are constructed and communicated through everyday interactions. As a result, learning how to work and act like a preparator or volunteer is a long-term process of socialization and hands-on experience. Individual practitioners' ongoing learning is a key component of how experts prepare their community—that is, how they define a shared, collective identity based on often-tacit norms of social and technical behavior.

We know a lot about how scientists develop their sense of identity (e.g., Traweek 1988, chap. 3; Delamont, Atkinson, and Parry 2000). That well-defined path of graduate degrees and field-specific positions and experiences is common for a subset of scientists, technicians, and other research workers. But fossil preparators lack formal training and credentials in fossil preparation and sometimes in science altogether. As a result, their apprenticeship-like learning demonstrates how people acquire hands-on skills and experience-based social norms. Scientists, after all, learn this way too, as do other kinds of craft workers. Without standardized training or shared credentials, preparators offer insights into how people learn to do good work and identify with a group of practitioners. Together, these two processes constitute the preparation of a community.

One way to understand preparators' training is as the process of joining an epistemic community (Meyer and Molyneux-Hodgson 2010) or epistemic culture (Knorr Cetina 1999). These are groups that are primarily

defined by members' shared knowledge and shared ways of producing knowledge. In these conceptions, all the rest of an epistemic group's work, such as training novices, tinkering with techniques, and shaping pieces of the world, is subsidiary to knowledge. From the broader perspective of preparing knowledge, however, a community's tasks of preparing evidence, future practitioners, techniques, and its own sense of collective identity are all interdependent as well as equally important. Knowledge is one component of this system rather than the ultimate one.

A better heuristic for capturing what unites research workers is the idea of a community of practice (Lave and Wenger 1991). A community of practice centers around learning as a description of everyday interaction and a mode of shaping future practitioners. Learners are immersed in a group of workers and given real though marginal tasks. Anthropologist Jean Lave and education scholar Etienne Wenger (1991) call this process situated learning, which happens through "legitimate peripheral participation" in a community of practice. Lave and Wenger focus on how novices learn, but really doing skilled work involves ongoing learning by all practitioners, from each other and from working with materials. As a community that *only* has situated learning—without coursework or written instructions—preparators powerfully illustrate learning from each other and by interacting with the world. Furthermore, how preparators learn to work with specimens demonstrates how defining good work is inseparable from defining the community that does that work. It is the iterative process of developing skills, techniques, and identities that unites workers as a community, beyond knowledge alone.

This chapter investigates how technicians prepare a community, which is made most visible in how they prepare people to join that community. Teaching potential new members is inseparable from the work of defining a community's norms and values, and therefore serves as an important indicator of how a community perceives, defends, and occasionally adapts its identity. Other forms of community preparation include negotiations of social order, task responsibility, and group governance (e.g., at meetings of the Preparators' Committee at annual SVP conferences), but these processes tend to be subtle and happen infrequently. Hence I focus on

preparators' training and socialization as illustrations of how skilled workers prepare their community.

How preparators select and teach novices (both staff and volunteers) in the absence of training programs highlights this community's conceptions of whether skills are innate or learnable. Crucially, most staff preparators work alongside volunteers. The presence of volunteers in research spaces is not common, especially in facilities that require extensive training and safety clearance (e.g., spaces with dangerous chemicals or machinery). Yet volunteers' participation in research has historically persisted in some fields, such as paleontology and astronomy, and has returned to other fields, such as ecology and archaeology, through citizen science programs in which scientists invite the public to collect and/or analyze data (Strasser and Hacklay 2018; Strasser et al. 2019). Like staff preparators, volunteer preparators apply embodied skills to make specimens researchable, but unlike staff, volunteers do not apply expert judgment to assess *how* to alter a fossil. That craftwork—the creative problem solving, as discussed in chapter 1—belongs to staff. This distinction may help protect preparators from being replaced by an unpaid workforce. It also, I argue, helpfully delineates preparators' community of practice by placing volunteers at its periphery rather than its core. Teaching and learning are thus a dynamic process of defining a community of practice, its techniques and skills, and its sense of collective identity.

WHAT IS A COMMUNITY?

Learning how to communicate and behave is the first step in joining a community of practice. Sociologist Harry Collins (2011) contends that novices first must learn a community's work language in order to participate in and therefore learn from the community. Lynch (1985, 16) agrees that social interaction enables learning: "Adequate access to the social order of the lab is inseparable from a competence [in] the technical practices." Moreover, according to Lave and Wenger (1991, 92), social acceptance decides novices' future in the community: "The issue of conferring legitimacy is more important than the issue of providing teaching." Rick, who

was hired as a preparator without preparation experience, described the value of preparators' social connections: "There's a path to becoming a part of their world. . . . This [lab] is a good place to start because there are a lot of connections with other people and SVP."

How then do people learn a community's appropriate social and technical behavior? Unwritten methods, as well as the unwritten nuances underlying written methods, rely on tacit knowledge, which must be learned from experience and person-to-person instruction. Collins (2010, 11) names three types of tacit knowledge: "relational" (usually not explained, but it can be), "somatic" (muscle memory, such that explaining a task is insufficient to teach it), and "collective" (only learnable through immersion in a society). Preparation work relies on all three as both a cause and effect of preparators' nonstandard, hands-on, unwritten, "situated" training. The tacit nature of much of technicians' knowledge may also explain why, as studies show, technicians feel loyal to and self-identify with their community of practice more than with the institution they work for (e.g., Barley and Bechky 1994; Zabusky and Barley 1996). Understanding how technicians learn to do their work as well as identify with their community is a crucial, little-understood issue in the construction of scientific practice and social order. From the perspective of knowledge preparation, how research workers learn skills and identities helps define their community, and influences how they understand the world.

Preparators' variety of tasks as well as lack of standard procedures and shared training could indicate an absence of community. For example, respondents to my 2010 survey listed job titles including "museum specialist," "museum technician," "academic technician," and "field and lab technician," in addition to the more specific "fossil preparator," "conservator," and "collection manager." What makes people with these various job titles identify as preparators? Despite their apparent heterogeneity, preparators manage to prepare a community that they identify with. Preparators, for instance, tend to subscribe to the PrepList email list host, attend talks in the Preparators' Session at SVP, and, importantly for my research, respond to an email request to fill out "Fossil Preparation: A Survey." To match the diversity of roles that fit under "preparator," the SVP website describes

its Preparators' Resources (2020) page as "a resource for those concerned with the collection, preparation and conservation of vertebrate fossils and the care and management of collections." These wide-ranging tasks are presented as connected and specific to preparators.

It's possible that the creativity and adaptability that enable successful work with diverse fossils, tools, social structures, and priorities also function as unifying values. Sociologists Stephen Barley, Beth Bechky, and Bonalyn Nelsen (2016, 137) observed this appreciation for flexible methods in several communities of medical and science technicians:

> Because much of technicians' work was a response to the vagaries of physical, mechanical, and biological systems, none of which could be counted on to function predictably, their understandings of these phenomena remained open to continual modification. The upshot was that the technicians' knowledge remained resistant to codification and, on occasion, articulation.

Standardization would inhibit preparators' ability to respond to irregular specimens and situations (chapter 1). This reliance on dynamic specimen-tailored methods and mindsets may help preparators unite as a community across job titles and institutions.

One way to understand preparators' shared identity is to find the common frame that encompasses their various activities. In Abbott's (1988, 59) model, as noted in chapter 1, a professional group claims jurisdiction over certain problems and tasks and thereby creates a group identity. For example, preparators claim jurisdiction over removing matrix and repairing fossils, even though they lack the shared training and codified problem-solving techniques of most professions. As a weak endorsement of preparators' jurisdiction, the "SVP Bylaws" (2009) state that fossils "should be prepared by, or under the supervision of, trained personnel." This bylaw is vague (what constitutes trained personnel?) and unenforced, serving as a recommendation rather than a rule. Preparing preparators' collective identity, then, relies on more subtle mechanisms than professions whose jurisdiction is defined by law and credentials, such as doctors and lawyers.

The types of questions that a community chooses to ask—and not ask—also indicate the beliefs and tasks that unite the group. Historian

Nicholas Jardine (1991) argues that the questions that scientific communities ask reflect their epistemologies and social composition. The kinds of questions that preparators ask about their work make sense to all preparators, suggesting that they share a "scene of inquiry" in Jardine's term (1991). Preparator Charles said of preparation:

> It's always decisions. . . . How much dirt can you remove from the specimen before you're endangering the specimen? . . . You got to remember that it's going to be handled, it's going to be shipped. . . . You have to do these things in anticipation of other things that are going to happen to that specimen.

The basic question of "how can we see and study this fossil?" relates to "how can we remove this matrix?" and "how can we protect this fossil?" which are bounded by "what are we willing to risk or sacrifice to see this fossil?" Removing matrix, for instance, removes information, including strata composition data, microscopic fossils (e.g., pollen), and trace fossils (e.g., skin impressions). Deciding how much information to destroy in order to see a fossil has no standard answer; the question itself, however, is intrinsic to every matrix removal task. Sharing these questions makes preparators a unified group, regardless of how they later answer these questions. By having shared tasks and questions about these tasks, they prepare a community for themselves.

One indicator of how preparators view their community is how they portray themselves and their work to outsiders. Objects and events help solidify group identity for both members and nonmembers, such as community-specific symbols (e.g., the DNA double helix as a symbol of biologists [Nelkin and Lindee 1995; de Chadarevian and Kamminga 2002]) and historic commemorations (e.g., the 1959 centennial celebration of Charles Darwin's *Origin of Species* that helped unite scientists around the new synthesis of evolutionary theory and genetics [Smocovitis 1999]). Every year, preparators contribute photographs that one preparator selects and compiles into a calendar, which serves as a visual representation of the community of preparators and their work. The calendar's more explicit function is as a fundraiser for an annual grant awarded "to further the field of Vertebrate Paleontology through the advancement of preparation,"

such as by funding training workshops ("Marvin and Beth Hix Preparators' Grant" 2020). The calendar's twelve photos imply that preparation relies on individual skill, scientific knowledge, and hard work. In the 2010–2017 calendars, half of the ninety-six images (52 percent) show people carrying out preparation work, such as removing matrix, gluing, casting, mounting, and fieldwork. Twenty-five percent of the photos imitate the style of research publications by depicting fossils alone against a neutral background, often including species names and scale bars. Most of the remaining photos (22 percent) showcase specimens less formally, such as next to a smiling preparator, on exhibit, and in before-and-after-preparation shots. Ironically, although preparators and their work are missing in publications, they are visible in the calendar prominently displayed in most fossil labs. By creating an artifact to represent their community, preparators further define that community.

PREPARING PREPARATORS

Preparators' Paths

As diversely trained technicians, preparators' experiences illuminate a variety of possible paths to working in science, even without a PhD. To capture a snapshot of this community's demographics, backgrounds, and opinions, I conducted a survey.[1] I don't know whether the survey garnered responses from a representative sample of preparators, of whom there exist no centralized tallies or lists.[2] I do not attempt a full prosopography of preparators, but these survey responses convey at least an idea of the preparator community.[3]

Many preparators' work lives include academic degrees in science. Ninety percent of the survey respondents have bachelor's degrees, and 37 percent also have graduate degrees (27 percent have master's degrees, and 10 percent have PhDs). Many of their degree fields reflect the diversity of sciences that study fossils, such as geology, biology, paleontology, paleoanthropology, paleobotany, and zoology. The survey respondents also listed degrees in seemingly unrelated fields, including linguistics, history, marketing, art, and literature. Seventy percent of the respondents have at

least one degree in a science subject. This is not as high as for many laboratory technicians, such as those in the disciplines that expect technicians to hold PhDs in specific scientific fields. There seems to be more room for diversity in preparators' education than in researchers' and other kinds of technicians' schooling.

Volunteering is important in preparators' backgrounds and job responsibilities. Half of the respondents (thirty-two) were or had been volunteer preparators. Fifty of the fifty-seven respondents (88 percent) who were full-time staff members trained volunteers, indicating the high numbers of fossil labs that host volunteers. Of the thirty-one staff preparators I interviewed, thirteen (45 percent) learned to prepare as volunteers. Nine (29 percent) were hired without experience and then learned on the job. Four (13 percent) taught themselves to prepare. Four others (13 percent) learned to prepare as science students and chose jobs in preparation instead of research. Thus most staff preparators I met had experience before they were hired (twenty-one, or 70 percent), most often as volunteers but also as amateurs or students. Carter, a fossil conservator, said of his coworkers, "We all started as volunteers. And we're quickly becoming put in charge of departments. It's a nice way in." Volunteering is considered a good way to learn how to work with specimens and, implicitly, participate in the community.

There also seem to be personality traits that correlate with being a preparator. My impression is that many preparators are introverts who are drawn to details, committed to their work and hobbies, and susceptible to perfectionism. They happily spend hours focused on one specimen while making small, precise movements. Unlike technicians who work in teams, preparators' primary tasks—matrix removal and fossil repair—require intense concentration and frequently involve a microscope, which excludes collaborators. Preparators tend to be tinkerers, like many technicians. Sociologist Park Doing (2004, 2009), for example, observed that synchrotron operators judge each other's lab skill based on how well they maintain their own cars and motorcycles. Preparators reported hands-on hobbies that seem more diverse and less mechanical than those of Doing's technicians, including playing in rock bands, tending rare orchids, painting and

sculpting, and collecting fossils in the field. Many foster countercultural interests, such as *Star Trek*, the *Rocky Horror Picture Show*, techno music, and role-playing games. They prefer to be informal. For example, everyone in fossil labs is on a first-name basis, and old jeans and T-shirts are the unofficial lab uniform (worn beneath white lab coats in the United Kingdom, though not in the United States). Many preparators participate in institutional social gatherings such as happy hour, communal lunches, staff parties, and show-up-to-play sports teams. They regularly crack jokes and tell stories, perhaps to compensate for their long solitary stretches of working on fossils. But these personality traits are not prerequisites for or indicators of preparation skill, of course. Without shared training or credentials, how can preparators assess whether someone is—or could become—a good preparator?

The Prep Test: Are Preparators Born or Made?

Experience preparing fossils is one sign of a preparator's ability, but most applicants for volunteer positions and some applicants for staff positions have never prepared fossils. As a result, many staff preparators assess applicants' *potential* skill by evaluating their untrained performance at preparing a fossil (Bergwall 2009; Brown 2009, 52–57; Brown et al. 2010, 181–182). The goal is to identify novices who are likely to prepare fossils well, thereby maximizing the return on staff's time in training them and minimizing the damage inflicted on fossils. In a paper about a volunteer training program they led, preparator Matthew Brown and colleagues (2010, 183) claimed, "In most cases a future preparator's potential can be judged within moments of a candidate's first attempt to prepare a specimen." As an example of how most preparators judge applicants' first attempt, Paul described his lab's approach: "I usually start [volunteers] on something simple that'll test their patience, usually scrappy fossil fish. We give them a pin vise and a little poofer—an air blower—and tell them how to clean the fish. . . . It tests them, to see if, A, they have the patience, B, if they can do it, [and] C, if they want to keep doing it." Preparators judge applicants' manual ability, patience, and interest through a "prep test" that matches preparators' training by taking place on the job, in the lab, by actually preparing fossils.

The design of this prep test varies by institution, but it is always given before applicants are trained so as to judge their preexisting capabilities. It is prognostic in that it is intended to predict an individual's future performance. But the prep test has no universal assessment criteria (except, perhaps, not destroying the fossil). Preparators judge tests differently depending on their labs' needs and their own values, such as preferring faster versus more precise work, or gregarious applicants for exhibit labs versus quiet applicants for behind-the-scenes ones. Labs that have "easy" fossils to prepare are more likely to accept less skilled applicants than labs with "difficult" fossils, which admit only the highest-performing applicants. Thus this test is not looking for universal aptitude but rather for how well an applicant fits a specific workplace. If preparators judge that a volunteer applicant "fails" a prep test, then they encourage the applicant toward positions outside the lab, such as in collection management or public outreach. A staff applicant who fails a prep test is not hired.

Using a prognostic test implies that a job relies on innate abilities like the "black art" of computer programming (Ensmenger 2010, chap. 2) and indefinable "right stuff" needed to be a good astronaut (Santy 1994). Mysterious, unlearnable skill can seem exclusive and high status, as opposed to well-defined skills that anyone might learn. By designing and judging a test, preparators assert control over their community of practice by selecting their coworkers and defining the characteristics of a good preparator.

As their prognostic test suggests, many preparators believe that the relevant manual skill cannot be learned. In 1982, preparator Bill Simpson designed a prep test for his lab at Chicago's Field Museum (Bergwall 2009). Preparators often credit Simpson with inventing the prep test, or at least being the first to use one consistently. The design of his test reflects preparators' common view of manual ability, which is that "you can either do it or you can't," as Simpson explained to me. Furthermore, Simpson continued, this test "was measuring just basic hand-eye coordination. . . . Preparation involves knowledge of the anatomy and being really good with your hands. You can learn the anatomy. I don't think you can learn to be good with your hands." The unusual aspect of Simpson's test is that he asks

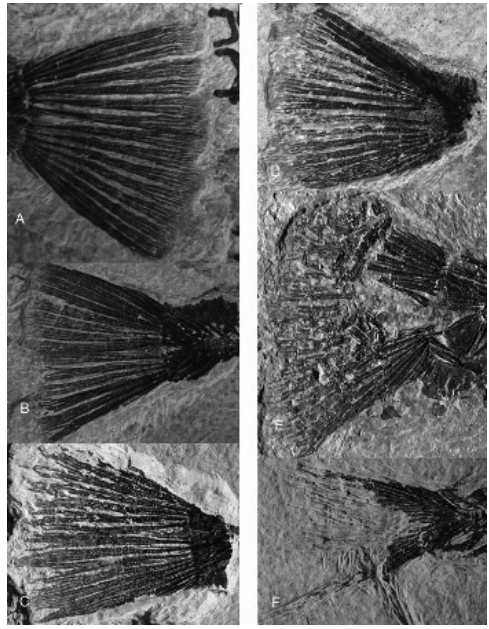


Figure 2.1
Photographs of several applicants' prep tests on *Priscacara* tails, showing various skill levels. A (top left) is a well-prepared "model test," while F (bottom right) is a poorly prepared "failed test" (Bergwall 2009, 39, reproduced with permission).

all applicants to prepare the same thing: the fossil tailbones of a *Priscacara* fish, of which his museum has many specimens. Simpson decided to use a consistent kind of fossil to facilitate comparison between applicants' results. He also believes that *Priscacara*'s anatomy differentiates applicants, telling me, "Most people that are good with their hands will have a fairly easy time doing preparation at the base of the fin, but you have this wonderfully gradual gradation to thinner and thinner bone as it goes out to the tip of the fin. Somewhere along there everyone's going to start having problems" (figure 2.1). Thus where along the fin applicants damage the bone indicates how good with their hands they are. Most labs use any available unimportant specimens instead of one particular species.

The applicant test that I witnessed at the closest proximity was my own, as a high school student, in the Dinosaur Lab at the University of

Chicago. Volunteers worked there every Sunday under the supervision of an undergraduate, Betty, who had been preparing fossils for two years. When I arrived, rock dust was floating through the air and the volunteers' pneumatic air scribes buzzed like dentists' drills. Betty handed me a pin vise and a little piece of dinosaur in a cardboard box. While I wondered why we weren't wearing gloves or encasing this priceless relic in glass, Betty pointed out the clumps of sandstone stuck to the fossil. She explained that I should chip them off in small pieces, without scratching the bone beneath them. Then she walked away.

I stared after her in astonishment and then turned anxiously to this balancing act of removing all the rock, but *only* the rock. The fossil was probably a chunk of rib or vertebra—bones considered sufficiently robust, common, and scientifically uninteresting to serve as tests and learning tools for novices. I scratched with the pin vise at millimeters of sandstone, surprised at how unsteady my hand was at that scale. One clump flaked off in one piece, popping cleanly off the bone surface. I was startled, but also strangely pleased at how smooth and shiny that newly revealed section of fossil was. I was learning how to notice, such as the visual details of the rock and bone, and the feel of the rock's resistance against my tool. Turning this multisensory awareness into decisions about how to work with an object relies on "synesthetic reason" (Paxson 2012, chap. 5). In this view, "an artisan habitus is less a matter of ability than of sensibility. It combines a synesthetic grasp of the materials with an ethic of doing a job well for its own sake" (Paxson 2012, 148).

"Good job," Betty said at my shoulder after a while, making me jump. I had not yet learned preparators' unspoken rule that if someone stands quietly in your peripheral vision, they want to talk to you. They wait for you to look up before they speak so as to prevent you from jabbing the fossil in surprise. I had missed the cue, forcing Betty to talk to get my attention. I had been thoroughly engrossed in the microworld of that fossil's bumps and striations and adversarial rock clumps, as preparators expect other preparators to be. Betty kept checking on me, and after a while she invited me to come back the next Sunday. I don't know what her criteria

were for passing the test, but I didn't damage the fossil. Despite my slow, unsure pace, Betty saw potential in me.

More recently, three volunteers who had passed a prep test described it to me as an indicator of hand-eye coordination, willingness to follow directions, dedication, love of fossils, and ability to perform repetitive work. Volunteers generally pride themselves on their ability to identify (and uncharitably laugh at) bad prep tests, such as fossils gouged by applicants. Recognizing and ridiculing bad prep tests asserts the volunteers' superior skill over the novices. The three volunteers credited the prep test as "a make or breaker" for applicants' admission to the lab. This all-or-nothing result reflects staff preparators' trust in the prep test as a reliable measure of applicants' potential ability. These volunteers' list of required skills matches staff preparators' except regarding love of fossils, which staff members don't consider a useful measure of a good preparator. That volunteers *do* may reflect their choice to work in the lab, which is usually motivated by their specific interest in paleontology

Preparators even interpret enjoyment as a sign of manual skill. Preparator Lisa Bergwall (2009, 37–38) published a list of "test criteria" to assess prep tests, including "did the candidate get bored?" Being bored would weaken an applicant's willingness to volunteer, but some preparators also see it as a sign of poor skill. Simpson said, "I would also ask people, 'Do you do things with your hands for fun? Do you paint, do you sew, do you build models like I did?' And if it was clear that they never did anything with their hands, well, people do what they're good at. They enjoy doing things they're good at." By assuming a link between skill and enjoyment, preparators use hobbies as an indicator of people's skills. Several preparators told me that people with preparation-like hobbies become more satisfied, motivated employees and volunteers. The volunteers I spoke with mentioned hobbies such as doing jigsaw puzzles (one volunteer makes his own), painting, drawing, making jewelry, and carpentry, all of which draw on manual precision and attention to detail. But I wonder if these hobbies are an effect of manual skill, as preparators imply, or rather a cause of it. Clearly, preparators' conception of manual skill as unlearnable shapes their chosen new recruits and thus their community.

Patience and Judgment as Skills

In addition to manual dexterity, preparators consider one personality trait to be necessary and unlearnable: patience. Marilyn, a volunteer at the Southern Museum, demonstrated preparators' characteristic patience when she told me that the fossil whale skull she was preparing was in hard, dense matrix that took a lot of work to remove. But she was not in a hurry, saying of the skull, "It's been around [for] sixty million years. It can wait a few more." Likewise, Kelly, a volunteer who searches matrix for microfossils (a task called microsorting) at the Northern Museum, said of her work, "It takes a lot of patience, and not everyone has patience." She considers it "a waste of time" to go too fast while microsorting: "The whole point is slow, careful, find everything. This isn't a race. It's not quantity, it's quality." Preparator Steve thinks patience is innate: "You can't teach patience to someone, because it's not in their psyche. . . . They're always going to be a restless soul. They're always going to be trying to rush it. [*parodying an impatient person*] 'I've got to see what the—ah, I've just chipped the edge off it.'" Being impatient is seen as a direct cause of poor work, such as overlooking microfossils or damaging specimens. The prep test is a chance for volunteers to decide whether they actually want to prepare fossils by trying it. Preparator Paul explained, "It all sounds exciting on paper to work on old dead things, but once you try it, it can suck. If you don't have patience, it can be a terrible thing to do [*laughs*]." Impatient volunteers can damage fossils and are likely to quit from boredom, thereby wasting employees' time to train them.

Preparators also name vision and visual practices as important skills; they consider the former innate and the latter learnable. One volunteer told me, "I flunked the prep test" due to poor vision in one eye. The staff agreed, blaming his damage to the test fossil on his lack of depth perception. (He was allowed to microsort instead, which doesn't require depth perception.) On the other hand, Bill described visual practices in terms of compliance rather than physiology:

> Sometimes I've seen students or people here using a [binocular] microscope and only using one eye. . . . So I'll tell them . . . if [researcher Frank] wants me to give that person a good fossil to work on, I'm going to advise [Frank]

> that I've seen this person only using one eye through the microscope. I don't think they're trustworthy enough to work on something good. And that gives them a little kick-start into learning how to use the tools and the microscope in the proper fashion.

For Bill and many preparators, proper visual technique means using tools correctly. It also indicates a willingness to follow directions. Note that Bill invokes the *scientist's* dissatisfaction to motivate the learner; Bill's dissatisfaction, as a mere preparator, is somehow insufficient.

The ability to visually differentiate matrix and fossil bone—which preparators and volunteers refer to as having "the eye"—is a critical, difficult, and learnable skill, separate from three-dimensional vision and trustworthy visual practices (figure 2.2). When Northern Museum volunteer Keith was not sure if lumps on his specimen were matrix or bone, he asked preparator Amanda, who identified them at a glance as matrix. Then

Figure 2.2
A preparator points a pin vise tip at a small, triangle-shaped fossil reptile's jaw subtly protruding from a lump of rock. Only someone with "the eye" can spot this specimen.

Keith said to me admiringly, "See, she's got the eye." He wasn't referring to Amanda's eyesight but rather her judgment. Ingold (2000, 354) argues that training functions not by teaching "formulae" or protocols but instead "by introducing novices into contexts which afford selected opportunities for perception and action, and by providing the scaffolding that enables them to make use of these affordances." Working with specimens, with guidance from experienced preparators, allows novices to learn to recognize the visual characteristics of fossil and matrix. Similarly, education researcher Philip Henning (1998, 116) found that refrigerator technicians diagnose mechanical problems based on "touchy-feely" sensory assessments of machines' temperature and sounds, which the technicians learn through experience and the advice of "old-timers" and other more experienced technicians (also see Orr 1996). Technicians' practiced sensory connection with objects, from refrigerators to fossils, matches Ingold's (2000, 354) claim that "practitioners' engagement with the material with which they work is an attentive environment, rather than a mere mechanical coupling." This sensorial engagement enables craft workers to use synesthetic reason and craft skill to embrace objects' variations and atypicality by altering their techniques to make the material comply with the workers' goals (Paxson 2012, chap. 5).

Besides manual skill and vision, preparators mention no requisite physical abilities. Most preparators sit at a counter or table to prepare, without moving much. This work suits the many volunteers who are past retirement age. Volunteers with bad backs often become microsorters to avoid lifting heavy specimens. But interestingly, I never heard preparators mention strength as a virtue, even though they regularly carry heavy specimens and tools. Despite the importance of manual skill, attributes of people's hands were not mentioned, unlike their eyes. Physical coordination is implicitly valued to prevent mishandling specimens, but many preparators I met are rather clumsy. They seem to step on others' feet, walk into furniture, and knock things over more frequently than the average person. One preparator was gently bending a plastic spoon during lunch, then accidentally snapped it and looked shocked. The ability to handle fragile fossils while being uncoordinated does not go unnoticed

by preparators themselves. One preparator described herself as clumsy and distractible. She thought that these traits made her a *better* preparator because she had to be aware that the clumsiness might "come out at any moment." This risk made her consciously vigilant when handling specimens. She considered this heightened awareness safer than being naturally coordinated.

Preparators prioritize manual dexterity, patience, and visual judgment over strength and coordination. Describing mainly cerebral versus physical abilities portrays preparation as skillful craft rather than brute strength. Preparation work can appear simple to nonpreparators, such as novices, researchers, institutional administrators, and the public. As a result, it is in preparators' interest to highlight the value of their skill and thus of themselves to their workplace through their criteria for their coworkers.

This lack of emphasis on physical traits may help explain the relatively minor difference in the numbers of men and women who are preparators. Fifty respondents to my survey were men (63 percent) and twenty-nine were women (37 percent). Of the thirty-one staff preparators I interviewed, nineteen were men and twelve were women. These numbers are not equal, but the lack of an even larger gender discrepancy in a scientific and technical field is unusual. For example, in 2010 only 20 percent of earth sciences faculty at the best 106 US graduate institutions were women (Currano, Marsh, and Vance 2014; Glass 2015; Pimiento 2016). In the nineteenth and twentieth centuries, women's contributions to science were largely dismissed as unimportant or illegitimate (e.g., Rossiter 1982; Oreskes 1996; Hartley and Tansey 2014). Preparators' more balanced gender ratio, however, suggests that gender discrimination is not a primary cause of their invisibility in scientists' publications. Fossil preparation aligns with traditionally "masculine" work in that it is dirty, manual, and involves tools and science. Yet it also relies on "feminine" attributes, such as fine-motor skills, patience, and appreciation for aesthetics (e.g., Traweek 1988; Faulkner 2007), which may encourage more women to try it. It's possible these stereotyped preferences cancel each other out numerically, resulting in more equal gender representation among preparators than in many kinds of scientific work.

LEARNING SKILLS AND SOCIAL ROLES

Skills for Staff

Hiring a preparator involves committing more time and money than accepting a volunteer, and also bestows the new employee with more power over the community. Yet the selection priorities are largely the same. The primary difference is that preparators highly value experience for staff positions and compliance for volunteer positions. Of the thirty-four preparator job openings advertised on the PrepList from 2010 to 2016, thirty (88 percent) required experience in tasks such as matrix removal, molding and casting, collection management, fieldwork, and fossil conservation. Four postings specified experience as "preferred" but not required. (Experience is generally assessed based on the amount of time the applicant has worked with fossils as an employee, volunteer, or amateur.) Despite this trend, preparator Mary lamented that experience is not always a factor in hiring: "There's still jobs that . . . want somebody to . . . be a preparator, but they want them to have a degree in geology or biology, and they don't really ask for experience in preparation." Mary, like many preparators, considers it a mistake to value an academic degree over preparation experience.

Some preparators are frustrated by the lack of consensus around what preparators should be able to do and thus who can be a preparator. Other groups' skills and membership are informed by guidelines set by professional societies. Preparators participate in scientists' main conference, SVP (which includes a Preparators' Committee and a Preparators' Session of talks; see Preparators' Resources 2020), and in 2014 created their own professional society, the Association for Materials and Methods in Paleontology ("About Us" 2014). But neither group credentials preparators or standardizes techniques. To address this gap, in 2012 a group of preparators led by Brown wrote a list of "essential competencies" for their community, which they posted on the SVP website (Brown et al. 2012). They modeled their list after the American Institute for Conservation's report about conservators' "essential competencies" (Perkinson et al. 2003), which was an approach Brown (2009) had long advocated for. The conservators' list includes specific academic degrees and technical protocols, while the preparators' list

is more open, focusing on general characteristics that preparators should have, such as "critical thinking" along with an "understanding" of fossils, tools, materials, conservation, and fieldwork. It also includes aspirational practices that the authors would like to become more widespread, such as "the preparator keeps records of all tools, techniques, and materials used to prepare or house the specimen" (Brown et al. 2012). This is not the current reality, but it mirrors conservators' dedicated documentation procedures that the list's authors admire. This document doesn't seem to have had much official impact (e.g., no job ads refer to it as guidance for applicants' skills), but it articulates the vision that one group of preparators have for themselves and their community.

In my early interviews, preparators mentioned seven general factors as relevant for job applicants. I then asked survey respondents to rank those seven factors (table 2.1). Sixty-seven respondents ranked skill, experience, and potential to learn as high-priority criteria, while formal training, interest in fossils, and meeting deadlines were lower priority.

Skill was ranked most important, and is arguably a combination of the next two most valued traits: experience and learning potential. The close rankings of experience and learning potential suggest that preparators value novices who can learn well in the lab as much as they value applicants who have prepared fossils before. One preparator, who was hired without experience, told me that hiring novices is preferable because the staff gets to control their training. Ironically, this preparator's boss told me separately

Table 2.1

	Technical skill	Preparation experience	Potential for learning or improving skills	Personality and how they get along with coworkers	Formal training in preparation	Interest in fossils	Ability to meet deadlines	Other
Average	1.7	3.0	3.1	4.5	5.4	5.4	6.0	6.8
Median	1.0	3.0	3.0	4.0	6.0	6.0	6.0	8.0
Mode	1.0	2.0	3.0	4.0	7.0	7.0	7.0	8.0

Note: Responses to survey question, "If you were hiring a preparator, what qualities would you consider most important in a candidate? Please rank the following options [top row of table 2.1], with 1 meaning 'most important.'"

that this inexperienced employee was "not working out" and would soon be fired, indicating that hiring inexperienced people is also risky. The crucial factor for preparators seems to be skill, or at least potential skill, with less concern for how it is acquired.

Volunteers are expected to have the same basic abilities as staff preparators, plus attentive instruction following. Archaeologists protect against volunteers' inexperience through highly standardized fieldwork practices: "Although there were a variety of different people with a range of skills and perspectives, their actions were made to be in certain respects the same. By erasing certain differences between people, these site conventions made it possible to elicit objectivity in the various finds" (Yarrow 2006, 24). Volunteer preparators don't follow standard "actions" because there are none. Instead, to ensure the reliability—or "objectivity"—of specimens prepared by volunteers, preparators direct and supervise volunteers closely.

As a result, preparators train volunteers to ask for help rather than make decisions. Leah, a volunteer at the Northern Museum, said, "You learn when to stop and ask questions" of the staff, such as "which tools, which adhesives, what to do next, what to look for." Preparator Marc emphasized the significance of teaching novices to ask for help: "One of the best things that you can do is know when to stop. See when you're getting into trouble and stop . . . [and] come to us for advice, because we'd way rather see you have a successful experience, an enjoyable experience preparing a fossil, rather than a frustrating one because something stops working. Because that will drive you crazy." Teaching volunteers to rely on employees is intended to keep them calm and happy, while also protecting specimens from inexperienced, potentially destructive preparation. Interestingly, Barley and colleagues' (2016, 141) study of multiple kinds of technicians found an opposite trend: "Although all technicians agreed that neophytes were expected to display a modest amount of hesitation or self-doubt, technicians expected an air of determination gradually to replace tentative behavior as newcomers perfected their skills and knowledge." Performing confidence in their work is important to technicians' identities, according to Barley and colleagues. Perhaps this is why staff preparators expect volunteers never to lose their tentative approach, which could be

a threat to the employees' status. Instead, employees expect volunteers to always act like novices by asking for help instead of trying to creatively problem solve (chapter 1). By training volunteers to prepare evidence but not techniques, preparators defend their own power domain.

Staff preparators view self-assessment, such as recognizing when to ask for guidance, as a crucial component of volunteers' skills and trustworthiness. Paul said his volunteers know when a specimen is too difficult: "If they get something too delicate they say, '[Paul], this one's for you.'" Similarly, Barry, a volunteer at the Northern Museum, wondered if he should realign the pieces of a geologically crushed vertebra by breaking them apart and then gluing them where they would have been in life. He said that when he finishes removing matrix from the vertebra, "that's when I'll ask the powers that be what they want me to do" about reconstructing it. In Barry's case, he was not unsure of his skills or abilities but instead unsure of what the staff—the powers that be—wanted the specimen to look like (i.e., crushed or reconstructed). Thus an important component of training novices is teaching them the boundaries of their power and the hierarchy of decision makers in their community.

Preparators also expect volunteers to commit to working in the lab so that the investment in training will pay off in volunteer-prepared fossils. Max said working with volunteers is "one of the joys of [my job], actually. Particularly when you get somebody who's really committed and stays on." Gary also appreciates volunteers who put in the time to improve: "We have a small corps of volunteers who have been with us for several years, and they're very valuable to us because they're skilled enough now that they can be assigned a job and left alone, pretty much." Even though volunteers are taught to *not* make decisions, they are arguably most useful to employees and institutions when they have gained enough skill and trustworthiness to work with less supervision. Preparators' different expectations for employees and volunteers help to prepare the community's social order.

Training in Action

Like staff preparators, volunteers must be trained and socialized as active participants in the lab's community of practice. Unlike employees who

learn on the job, volunteers are occasionally trained en masse. Training varies in structure from brief instructions followed by independent work with periodic check-ins to a few rare multiday courses. Though unusual, training programs' design and content show how preparators prepare their community by enculturating new members. Strikingly, volunteers are taught to prepare evidence through constitutive cleaning and specifically *not* to prepare techniques.

Training novices includes demonstration, explanation, and learning by doing. Vanessa, a preparator and conservator, trains volunteers to build storage containers for fossil fish: "I give them a crash course in how you handle a specimen, how you handle notes . . . how the finished product should look. . . . I show them and work with them on how to do everything. . . . But every tray, every specimen, is a little bit different, so you're constantly adjusting as you go." Adapting practices to variations in objects is a crucial component of preparing evidence. By working alongside volunteers, Vanessa guides their work so that they learn her techniques and acceptable alterations to them. Working with them also allows Vanessa to supervise their work closely, and keep them from straying into unapproved techniques or innovations. She builds relationships with them as well, such as by labeling the "strange fish drawer" and "sparkly fish" specimens to "make the volunteers laugh" and "keep them interested" in the project. At the Northern Museum, volunteers and employees also work side by side. Amanda recognizes the advantages and disadvantages of this system in that it is difficult to schedule enough employees to work alongside volunteers in the museum's two labs, but it is valuable that volunteers can easily ask the staff questions. Implicitly, it also makes it easier for the staff to supervise volunteers. Preparator Amanda prefers this arrangement over the Southern Museum's, which she had recently visited and where staff preparators work in a separate wing and volunteers have to telephone them to ask questions. Most preparators share her concern about leaving volunteers without supervision or easy access to help.

Preparators typically train novices by guiding them through the work on a particular specimen from start to finish. This approach encourages novices' commitment to that fossil, allows continuity of preparation, and

enables novices to learn all the steps of preparation, from opening field jackets to painting specimen numbers on finished fossils. It also means novices' ongoing learning requires employees' supervision and advice. For example, preparator Carla gave volunteer Maddie specific feedback on the fossil fish she was preparing: "I like right here where you've kept the scales on." When Tim was learning to prepare on the job as a staff preparator at a university lab, he remembers receiving detailed feedback on his first specimens: "[Another preparator] said, 'You've gotta do a little bit better job,' because I was going over [the fossils] so fast I wasn't really getting all of the sand. . . . I had to go back over quite a few of them to get them to the state where we could actually properly mold them and cast them and have them be nice clean fossils." Feedback helps novices learn to identify good versus bad work. These values are not obvious or codified, so understanding them is a crucial part of belonging to the community of practice. Furthermore, explaining these values to novices helps experienced practitioners recognize and reflect on their community's usually tacit beliefs and priorities.

Many of these values and techniques were articulated in a training program for twenty-nine volunteer preparators run by the Smithsonian National Museum of Natural History's Paleobiology Department in 2008. Preparator Steve Jabo and volunteer Abby Telfer organized the program and hired four other preparators as instructors. They later wrote at least one conference talk and two publications about the program in hopes that it could serve as a model for other labs (Jabo 2009; Brown et al. 2010; Jabo et al. 2010). The program's goal was "stocking the fishbowl"—that is, recruiting and training volunteers to prepare fossils in FossiLab, the museum's newly reopened glass-walled exhibit lab (Jabo 2009). The program was a six-day course on preparation along with a five-day course on molding and casting. This program demonstrates how preparators prepare their community by preparing future practitioners.

The instructors' priorities for selecting trainees were broader than the skill-focused prep test: "To gauge people's realistic commitment to the job, whether or not they had reasonable personalities, and whether or not

they were going to be physically capable of doing the work" (Jabo et al. 2010, 173). The first step was an online application, of which one section asked the applicants to self-assess on a list of abilities and personality traits, from good vision and ability to sit or stand for a long time, to "patient, careful, observant" and "willing to take direction" (Jabo et al. 2010, 171, appendix 1). The applicants were also asked about their hobbies, mirroring Simpson's approach, because "volunteers who enjoy preparing fossils tend, also, to engage in leisure activities requiring patience and planning, such as bridge or chess, or requiring close attention to visual cues, such as solving jigsaw puzzles . . . or involving intense and sustained appreciation of nature, such as hiking, bird watching, or collecting natural history specimens" (Jabo et al. 2010, 171, appendix 1). The instructors drew these indicators from their own and their coworkers' characteristics. Science and education featured in the application too, in questions about academic degrees and "please describe briefly how you learn about science and nature, and what topics interest you the most" (Jabo et al. 2010, appendix 1). The applicants were then interviewed, primarily as an opportunity for them to visit the lab and meet the staff. The staff rejected 30 percent of the applicants.

The 29 selected trainees were taught to be useful for that specific community by learning tasks suited to local researchers' projects and the museum's collection, such as preparing fossilized plants as well as animals, sorting microfossils, molding and casting, and building storage jackets (Brown et al. 2010, 181). Each topic included a lecture, demonstration, and "hands-on" practice (table 2.2).

The volunteers practiced each technique with explicit directions. For example, "instructors drew instructions on the matrix with a marker directing students to work within a certain area, with arrows indicating in which direction preparation will be most effective, and estimates of approximately how much time they should spend in a given area based on their skill level" (Brown et al. 2010, 181). Trainers thus left little for volunteers to decide or figure out through trial and error, encouraging them instead to concentrate on handling tools, removing matrix, and not

Table 2.2

Day 1	Lecture: Who are we? What is paleontology? What is preparation?
	Lecture: Lab safety and lab orientation, lab ethics/manners
	Lecture: Specimen handling
	Lecture: Documentation
	Lecture: Problem solving in the lab
	Demonstration/Hands-on: Opening field jackets
Day 2	Tour: Collections and basement with emphasis on preparation/conservation
	Demonstration: Intro to preparation with airscribe
Day 3	Lecture: Adhesive and consolidant basics, how to mix, how to apply
	Demonstration/Hands-on: Practice with airscribes, use of pin-vice and picks
Day 4	Hands-on: More practice with airscribes
	Hands-on: Use of pin-vice and picks
	Demonstration: Temporary jackets and stabilizers
	Demonstration/hands-on: Sediment washing and microfossil sorting
	Hands-on: Practice with pin-vice and picks
Day 5	Demonstration: Creating padded plaster jackets
	Hands-on: Specimen prep
Day 6	Tour/lecture: Basic vertebrate anatomy, why do you need to know it?
	Conclusion: Practicum/evaluation

Note: The curriculum for a training program for volunteer preparators includes explanation, demonstration, and "hands-on" practice. *Source*: Brown et al. 2010, 180.

damaging fossils. Marking matrix also taught volunteers to follow directions, as it was immediately clear to the staff if volunteers did not remove the matrix as directed. I have seen preparators in other labs use this technique with novices too. The program mirrored the typical ways of selecting and training novices, just scaled up and formalized to serve many learners at once.

The instructors valued explaining the rationale behind the techniques as well as how to conduct them. They thought it was important, for instance, that "students see that the lab is using Butvar B-76 as an adhesive not because there is a 50-year supply in the basement, but because it fits within a universal standard in the field" (Brown et al. 2010, 184). They presented the glue as the best option and not just the convenient one because they consider it important to justify all techniques (chapter 1). Also, this adhesive is not actually "universal" or a "standard." Instead, these

preparators believe that it *should* be a universal standard in fossil preparation because it is better for specimen conservation. Hence the instructors taught the learners according to how they want the field to become, not necessarily the status quo. Teaching to a desired future exemplifies how training prepares a community.

For instructors, the intended "core messages" of the training program were: "preparators take their work seriously; the techniques, materials, and methods used have a basis in scientific methodology; preparators respect the specimens and the conservation ethic" (Brown et al. 2010, 184). Promoting these messages to volunteers "demonstrates the institution's commitment to high quality fossil preparation" (Brown et al. 2010, 184), while simultaneously constructing a concept of what high-quality preparation means and producing volunteers who follow that ideal. Communicating practical skills and techniques as well as ideal visions of the work and the workers is a crucial component of preparing communities.

The program succeeded in the goal of providing volunteers—stocking the fishbowl—for glass-walled FossiLab: "Twenty months after the training, 62% of the trained volunteers are still working in FossiLab. . . . Anecdotally, this is a better retention rate than has been previously encountered by the VP [Vertebrate Paleontology] Lab" (Jabo et al. 2010, 175). Thanks to the program, more fossils were being prepared by trained preparators without pay in an exhibit for the public. To continue this success, instructors encouraged community building: "Productive volunteers must feel that they are doing 'real' work, that they are part of the larger mission of the institution, and that the institution cares about them. Face-to-face time with the permanent staff is the best way to convey this" (Jabo et al. 2010, 175). Studies find a clear correlation between volunteer-staff relations and volunteer commitment and retention (e.g., Bussell and Forbes 2002, 250–251). This training program's focus on skill development, justified techniques, and social inclusion reflects preparators' typical situated learning. It strives to convey the skills, knowledge, and behavior valued by the community of preparators, while also training workers to embrace ideals that the instructors want to promote more widely.

THE ROLE OF VOLUNTEERS IN A COMMUNITY OF PRACTICE

Why Host Volunteers?

Why do institutions bother to recruit, test, train, and supervise volunteer preparators when so many skills are required? Staff members answer this question both financially, in that volunteer labor saves salary costs, and in terms of institutional goals, by viewing volunteers as recipients of public outreach and education efforts. For my purposes, volunteers serve as a counterexample to technicians. Specifically, volunteers prepare evidence by constitutively cleaning fossils, but employees actively discourage them from innovating, tinkering, or applying craft judgment to choose or design techniques. Preparing techniques is the fiercely defended domain of staff preparators. In some contexts, volunteers do control their techniques, such as citizen scientists who pioneer new ways to collect or organize data (e.g., environmental monitoring methods [Ottinger 2013] and community-based clinical drug trials [Epstein 1998]). But generally, staff members enforce research volunteers' compliance and limit their creativity, perhaps because employees are responsible for volunteers' work. How employees enact this distinction is an example of how they prepare their community.

Most museum volunteers' work is relatively unskilled, such as staffing information desks, giving tours, or doing collection management work like data entry. In comparison, volunteer preparators undergo long-term, though informal, training. Many fossil labs have far more volunteers than staff members, such as the Denver Museum of Nature and Science's 125 volunteers and 3 staff preparators in September 2011 ("Earth Sciences Labs" 2020). Of the fourteen labs I visited, twelve hosted volunteers. (Another has since launched a volunteer program.) Preparator Carla explained that "it's a team effort" of volunteers working alongside the staff members. As a result, employees view volunteer preparators more like collaborators than they do other kinds of volunteers. Luckily, paleontology is popular and many potential volunteers request to work with fossils, providing a large pool for employees to select from.

Many fossil labs host volunteers for financial reasons. Conservator Carter said of volunteers, "What's now driving our research preparation

program is to actually bring people in and train people up. We will never have enough staff to do it ourselves." According to Luke, a researcher at the Northern Museum, volunteers make it possible for the museum to achieve much more than it can pay for: "We depend on the volunteers. I think we have about 1,100 of them [in the museum]. . . . We couldn't afford to replace all that. We would just be doing a lot less without them." To quantify volunteers' labor, let's consider the Southern Museum's paleontology department. As reported in a departmental staff meeting that I attended in October 2010, the department logged 10,366 volunteer hours in 2009. That equals 5.2 person-years, meaning the hours worked by about five full-time workers in a year.[4] This enormous number includes volunteers who give tours, talk to visitors in the galleries, conserve and organize fossils in the collection, update the collection database, contribute to various research projects, and more. But this number is actually incomplete; it omits the hours worked by volunteers in the museum's glass-walled preparation lab. According to the lab coordinator, those volunteers alone contributed 3,775 hours—almost 2 person-years—in 2009. The exhibit lab volunteers' hours were also increasing; they had already logged 3,373 hours in just the first ten months of 2010. The department chair explained that 2011 budget predictions were not good; as a result, he emphasized supporting and growing the volunteer workforce to compensate for the reduced funding.

Volunteers are not, of course, entirely free labor; they consume a considerable amount of staff time. Preparator Jay told me that volunteers are "nice people" and the department relies on their work, but that they are "a time sink" for him in that he spends a lot of his workday supervising them. For that reason, Max only allows a few volunteers in his lab: "I don't like having a lot of trainees under me because I like to prepare fossils myself. [*laughs*] And I don't really want to spend my whole day advising other people and looking over people's shoulders." As studies show, thinking of volunteering in terms of cost-benefit analysis for both volunteers and institutions reveals each group's needs and goals, such as enjoyable work, a supportive community for volunteers, and reliable, productive volunteers for institutions (e.g., Bussell and Forbes 2002, 246; Handy and Srinivasan

2004; Edwards and Graham 2006, 21; Handy and Brudney 2007). Deciding to volunteer and deciding to host volunteers are also complicated decisions that involve more factors than cost-benefit analysis can capture. Significant but difficult-to-measure factors include benefits to institutions from building a corps of local supporters, benefits to the health and happiness of volunteers, and altruism by volunteers as well as institutions.

For skilled work, volunteers' output rarely equals the cost of employees' time investment in training them. Seeking free labor therefore can't entirely explain why institutions host these volunteers. Another explanation is to perceive volunteers as participants in institutions' missions of education and public service. Preparator Gary explained, "We really consider volunteers more of a public outreach aspect, of developing museum friends. . . . We certainly respect their work and appreciate it, but it's not something that adds to our productivity." Volunteer programs are thus one way for institutions to fulfill their "social responsibility" to provide education, community, and skill development for the public (Edwards 2007b). In this view, the output of fossil labs broadens beyond prepared specimens to include community members who appreciate science and museums.

Volunteer preparators' roles also depend on the institutional context. According to Linda, a former preparator at the Northern Museum, volunteers at first had contributed primarily to public displays by staffing the glass-walled exhibit lab. She explained, "The specimens [that the volunteers] are given to work on, they're not critical specimens. So their role seems to be to do the work that isn't otherwise going to get done" while providing a tableau for visitors to watch, "so it looks like there's a lot of work going on" in the glass-walled lab. Preparing less scientifically significant fossils to give the public something to see is more of an educational and display-oriented role than the research role that staff preparators have. But after the museum reduced the number of staff preparators from five to two, Linda noticed that volunteers began preparing more scientifically valuable specimens. She said, "The volunteers themselves seem more important now because there are so few paid preparators." The complex and dynamic nature of this institution's context is evident in the roles of volunteers as demonstrators for the public and/or as preparators for researchers.

Why Volunteer?

Volunteers, as the majority of preparation learners and an important source of future staff preparators, illustrate how practitioners' motivations and identities help prepare their community. So what is it like to be a volunteer preparator? Despite their unusually skilled work, volunteer preparators' motivations largely align with those of other kinds of volunteers, such as by justifying their volunteering as educational, fun, social, and supportive of a worthy cause (Wilson 2000; Bussell and Forbes 2002; Boraas 2003; Mutchler, Burr, and Caro 2003; Edwards and Graham 2006; Grazian 2015, 108–114).[5]

Studies show that many volunteers pursue volunteering to develop career skills or job opportunities (Bussell and Forbes 2002, 249). Motivations of learning and career goals are also evident in Deborah Edwards's (2005, 5) survey study of 641 volunteers in a history museum, an art gallery, and a science museum in Australia. Of Edwards' respondents, 74 percent wanted to gain new skills by volunteering and 23 percent specifically wanted to gain work skills. Preparator Claire noticed that the number of volunteers rises when the national economy worsens as people try to add to their work experience when jobs are scarce. Yet a review of studies of volunteers found that "reliable social science evidence to support the idea that volunteering actually helps people find jobs, or improves the quality of those jobs, is scarce" (Wilson 2000, 232). It's possible that doing the relatively unskilled work that is typical of volunteering doesn't develop or demonstrate valued professional skills. This finding might also reflect that while volunteering can lead to a career in some fields, so few jobs exist in these fields that few volunteers are actually hired even though many of the staff were once volunteers. For example, zookeepers are expected to spend significant time in unpaid internships before they are hired, creating a career-oriented focus for some zoo volunteers (Grazian 2015, 87–88). Like preparators, there are far more zoo volunteers than zookeeper jobs. So only a small percentage of volunteers are realistically striving for a career in these fields, even though most current practitioners began as volunteers.

Many volunteer preparators talk about their work as meaningful because it serves the museum and science in general, but they don't

consider their work or themselves to be part of research. Some volunteers want to lessen the strain on staff preparators by producing fossils for them, some enjoy educating the public about preparation by working in glass-walled labs, and many value contributing well-prepared fossils to the museum's collection. The next logical step of why fossils and collections are important is that they enable research, but volunteers rarely extrapolate from their work to scientists' work. They seem to see the two as only indirectly connected. Keith, for instance, thinks the department is full of "good people who are actively doing stuff that's going to further the world of knowledge, and I'm along for the ride." He does not consider himself an active participant in knowledge production. Larry explained that while "science at the surface level interests me," such as identifying fossil species, he is not interested in doing fossil research, and noted, "That's why I'm not a paleontologist!" Volunteers tend to be more interested in their own learning than in producing knowledge through research.

Some volunteers are driven by an interest in fossils, sometimes obsessively. Like many volunteers (and other research workers), Barry's fascination with fossils began as a child. As for volunteering in the lab, "I love it. It's the highlight of my week." Milton echoed a widespread response when he told me in a serious tone, "Why do I volunteer? Because they won't pay me." Two of his fellow volunteers, Jack and Vince, agreed, saying respectively, "I answered a call for dinosaurs" and "A fossil lab? [*raises hand*]" They made it sound like an obvious answer. Many volunteers' reactions implied, "why wouldn't I volunteer?" as though it is too good to be true that they get to prepare fossils. Similarly, an ethnographic study of computer technicians found that they, like many volunteer and staff preparators, often describe their "love" of their work and "amazement that people would pay them to pursue something they loved" (Zabusky and Barley 1996, 197–198).

Love, though, does not necessarily make people good volunteers or preparators. Staff preparator Marc found that some volunteers can be "very, very enthusiastic, but they don't really have a good skill set and they're very slow to develop, and so you keep them on the ribs and whatever, and sometimes even that's kind of scary [*laughs*]." If Marc does not trust volunteers' skills, despite their enthusiasm, he has them work only on ribs,

as sturdy, predictably shaped bones that are relatively uninformative for researchers. Carla once rejected a potential volunteer because he failed the prep test—he "annihilated" the fish fossil, she said, aghast—and because he was "a fossil geek" who just wanted to be around fossils on a fanatic level, "because they have magical powers," Carla scoffed. "I don't want people like that around" the lab, she said, meaning those who volunteer for what she considers the wrong reasons. Preparators deride such passionate volunteers as "fossil geeks," even though "fossil geek" can also be used affectionately. Some employees even self-identify as fossil geeks. Zookeepers scorn "bunny huggers" for the same reasons, as eager potential volunteers who focus on their own interest in animals more than on the animals' well-being (Grazian 2015, 231–235). Zookeepers consider bunny huggers to be overly emotional and uninformed about animal care, and they often refuse volunteer applications on these grounds.

The social aspects of volunteering can be as important to volunteers as the actual tasks. Many value spending time with people who share their interests. While chatting with other volunteers about geology and fossils, Ted said to me, "This is why we're volunteers, so we can talk about rocks." Kelly finds her microsorting work "fun . . . when you're working with other people and trying to figure out what you're finding," thus combining socializing and learning. Volunteers frequently take breaks together. Staff also recognize the significance of community for volunteers. Carla said that she and coworker Amanda try to make the lab "inviting, educational, interesting, [and] convivial" for the volunteers to "make them feel like part of the team" along with the staff. Ways to do that include, she said, "giving them important specimens to prepare, giving good feedback," and encouraging them to ask questions.

But community is rarely volunteer preparators' primary motivation. Rather, they tend to enjoy preparation as a solitary, all-consuming task. For example, lab manager Amber suspects that Alison, a mother of three, likes to volunteer because the lab is quiet and has no distractions, unlike Alison's home. Sometimes when I spoke to volunteers in the lab, they wouldn't look up from their fossils or would turn on a noisy tool that prevented conversation. These gentle dismissals demonstrate their commitment to their

work (while also usefully suggesting that my presence did not significantly alter their behavior). Volunteers are usually keen to discuss their work with an interested listener (e.g., each other, the staff, or me), but they do not allow these conversations to interfere with their main reason for being in the lab: preparing fossils. Thus volunteers adopt and reinforce the social norms of the preparator community by valuing learning, careful work, and like-minded fellow practitioners, even though volunteers are permanently relegated to the periphery of that community. How preparators achieve that relegation is a mechanism of preparing their community.

PREPARING SOCIAL ORDER

How Staff Prepare Specimens

How do staff avoid being replaced by the skilled, unpaid workers they train? In other areas of volunteering, such as hospital work, there is a clear division of labor between staff and volunteers that is largely based on which tasks require credentials (Handy and Srinivasan 2004, 50–51). Without credentials, volunteer and staff preparators have to construct this division of labor locally and repeatedly. They employ concepts of "simple," "easy," "difficult," and "complicated" to differentiate between the appropriate fossils, tasks, and tools for volunteers versus for the staff, thereby distinguishing two levels of skill and status. The crucial difference lies in the autonomy to choose and design methods, which staff preparators claim for themselves and forbid for volunteers (Wylie 2015, 49–51).

Preparators perceive their work as divisible into two levels of skill. Anne believes that the simpler parts of preparation should be learned by anyone who handles fossils, including volunteers and researchers, "to at least know . . . how to piece together a specimen themselves with an archival adhesive, basic techniques, and basic understanding of good preparation and conservation principles." Of course, even this supposedly baseline work requires skill and alters specimens by preparing them to be evidence. The instructors of the National Museum of Natural History's volunteer training program were trying to teach that level: "Creating

Master Preparators was well beyond the scope of this programme, rather, providing a consistent knowledge base among the volunteer pool and teaching them when and how to ask questions was the goal" (Brown et al. 2010, 180). They don't specify what master preparators know or do, but it is somehow different from what they were teaching volunteers. Preparator Olivia describes preparation as "basically just being patient" and "not a difficult thing to learn"; however, "it's extremely difficult to excel in prep," such as "to get very creative in prep." She differentiates between "simple" tasks and those that require a "creative" or "artistic" approach, such as specially tailored techniques and tools (chapters 1 and 3).

These conceptions of "basic" and "complex" preparation influence and are influenced by who does the work—volunteers or the staff. Preston, a researcher at the Northern Museum, told volunteer Keith about a dinosaur skeleton he had recently collected that might represent a new species and had been preserved in hard, dense matrix. Keith responded sarcastically, "Glad to hear that the rock's really hard!" meaning that it would be difficult to prepare. Preston smiled and said, "That's why I'm saving it for [Amanda]," a staff preparator. Preston had already decided that a staff preparator—not a volunteer—would prepare this challenging and scientifically significant dinosaur, reflecting the widespread assumption that volunteers are less skilled than employees. The crucial difference in their skills, I argue, is whether they are permitted to prepare techniques by tailoring their approach to each specimen. Henry, a researcher at the Southern Museum, also distinguishes between volunteer and staff preparators' skills when assigning his unprepared fossils: "Most of my stuff is smaller so it requires really specialized skills, and I wouldn't entrust it to just anyone. If we get big things, then some of the preliminary work somebody [a volunteer] can do under the supervision of one of our regular technicians." This distinction in skill and supervisory power preserves staff preparators' higher status and arguably protects them from being replaced with a volunteer workforce—a problem faced by other kinds of workers. In some cases, workers' fear of job loss has led to union contracts protecting paid positions from volunteer replacement (Pimm and Wilson 1996; Macduff 1997; Zahnd 1997; Handy and Brudney 2007). Preparators

don't express this concern, perhaps because researchers expect the staff, not volunteers, to prepare their most important fossils.

How Volunteers Prepare Specimens

Workers use specimens to articulate their social order, particularly the distinction between staff and volunteer preparators. Some specimens—especially small, difficult, and important ones—are reserved for staff preparators, while others—for example, "simple" fossils, Henry's big things and preliminary work, and microsorting—are set aside for volunteers. Researcher Maurice considers sorting his microfossils to be a volunteer-appropriate task: "Almost anybody can do it if you're careful." Amanda said that often she prepares a specimen until it's "easy enough for a volunteer to do . . . because it's a waste of *my* time" to prepare more straightforward areas, such as smooth bone surfaces. For instance, to economize her paid time and greater skill, Amanda delegated part of one skeleton to a volunteer: "I really shouldn't be working on the tail; it's a really simple shape." The specimens in preparator Gary's lab require only one skill level: advanced. He explained, "We don't have a lot of semiskilled prep work, you know, not a lot of concentrate picking [microsorting]." As a result, the lab hosts only a few volunteers. Gary expressed this distinction between staff- and volunteer-appropriate work in terms of the lab's overall productivity:

> Most of the stuff that we have, within ten minutes of beginning the preparation on the thing you're at a point where there are decisions you have to make . . . that can really impact the research value of that specimen. Very critical, critical preparation. And as soon as a volunteer comes up with something like that, you're over there working with them and you're not getting your work done.

Decisions, then, are the boundary of volunteers' work. Even with appropriate skills to remove matrix and repair breaks, volunteers are not trusted to make choices about altering a specimen's appearance. Whether they might be capable of this judgment is irrelevant; preparators don't permit volunteers to stray beyond their instructions. Though volunteers and staff frequently work side by side on seemingly similar tasks,

researchers and staff identify a clear distinction in their skills and right to make decisions.

Staff preparators and researchers typically decide whether a specimen is volunteer friendly. For instance, preparator Kevin suggested to preparator George that they give "the little rhino skeleton" to a volunteer to prepare. George agreed because "it's easy, it's in soft matrix" that will come off the bone without much specialized work. At the Northern Museum, preparators Amanda and Carla looked through a list of unprepared specimens to find an appropriate one for a newly arrived volunteer:

> **Carla**: Maybe we should start her on that [*pointing to a bone labeled "indeterminate"*].
> **Amanda**: Yeah? Easier shape, you think?
> **Carla**: Yeah.
> **Amanda**: Maybe [it's] a neural spine. Yeah, that'd be fine.

An easier shape, usually meaning simple and straight, is less liable to surprise or confuse a volunteer and provoke damage. Most preparators also take volunteers' preferences into account to "make people happy" with their projects, as Amanda put it, as well as capable of doing them well. For that reason, preparator Brad and his coworkers find it difficult to fire poorly performing volunteers because "we're too nice." He reasoned that if these volunteers are preparing "a big enough bone with soft enough rock, they're not really going to hurt it." Assigning appropriate fossils can compensate for volunteers' (lack of) skill, to some extent. Likewise, Mary limits volunteers' tools to protect specimens: "I only let a couple of them use the Chicago pneumatic [air scribe] . . . because it's a little too brutal, and if you don't really know what you're doing, then you might totally destroy things." This perception of volunteers as somewhat risky and unpredictable is common. It may further justify preparators' refusal to let even skilled volunteers make decisions beyond constitutive cleaning.

When deciding which fossils to assign to which volunteer, staff preparators prioritize volunteers' skill over their longevity in the lab. Favoring "expertise rather than experience or seniority," as preparator Brad put it, is common among technicians (Zabusky and Barley 1996, 201). One

volunteer, for example, started learning how to prepare small fossils under a microscope and "got it" as if he'd been doing it forever. Brad said, "He just had the touch, the touch of an artist." As a result, he "gets the primo fossils" to prepare, despite his recent arrival in the lab. Note that even this talented volunteer remained under Brad's supervision and direction; skill is not sufficient to prepare techniques, which requires staff status. This distinction between the staff and volunteers delineates tasks that only staff preparators can do—specifically, prepare challenging and important fossils, assign fossils to others, supervise volunteers, and choose and design techniques—and thus cements their role as an irreplaceable part of the lab, institution, and research.

CONCLUSION: LEARNING TO BE A COMMUNITY

By working together to develop skills, define social order, and initiate future practitioners, individuals unite themselves into a community of practice. Technicians can prepare their communities in a variety of ways, from requiring formal science training to welcoming diverse backgrounds. In general, though, all skilled communities, including scientific ones, encourage learning as a way to unify a group. By learning from each other and their materials, and sharing their knowledge with each other, technicians establish hierarchy as well as shared values and practices. This focus on ongoing learning, no matter one's level of experience or skill, can help a community stay dynamic, flexible, and creative.

How preparators train each other demonstrates the core skills and values that underlie their work and identity. Specifically, preparators want new members of their community to have manual skill and patience, which they assume cannot be learned but can be improved with practice. They believe a good volunteer preparator should follow directions, and a good staff preparator should train novices, select and adapt techniques, and prepare difficult fossils. Volunteer and staff preparators, like scientists and craft workers, learn skills, techniques, and social norms by working with supervision in a community of practice. Many staff members first learned to prepare as volunteers. Why then do staff preparators denote themselves

as decision makers and volunteers as decision followers, regardless of individuals' skill or experience? This distinction points to the primary mechanisms of preparing a community: continuous learning through interactions with people and objects, and ongoing negotiations of identity and social order. Therefore the highest power in a community of practice is training others to apply your techniques and follow your social norms, as staff preparators do.

One explanation for the strenuous boundary work that preparators do to separate themselves from volunteers could be preparators' lack of formal training. On paper, their primary qualification is years of preparation experience, which can be similar for the staff and volunteers. Sociologists Peter Whalley and Stephen Barley (1997, 40) argue that "conscious attempts to construct skilled identities should be most common among technicians involved in occupationalizing amateur work" to ward off perceptions of their jobs as unworthy of paid status. To mark their professional claim to preparation over volunteers, preparators refer to two levels of tasks and associated skills, which are defined by the specimens and tools that they consider suitable for volunteers versus the staff. Although staff preparators bear responsibility for specimens and are (usually) more skilled and experienced than volunteers, the key distinction is that only staff preparators may select and adapt techniques. This approach is apparently succeeding because preparators do not express any fear of their jobs being replaced by volunteers' unpaid labor. For example, Max is impressed by and proud of his volunteers' skill, not jealous or worried about it: "Some of them are better preparators than some of the professionals that I know [*laughs*]." The next chapter investigates staff preparators' distinctive power and skill of preparing technologies.

Preparing Dinosaurs

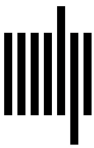
The Work behind the Scenes

By: Caitlin Donahue Wylie

Citation:

Preparing Dinosaurs: The Work behind the Scenes
By: Caitlin Donahue Wylie
DOI: 10.7551/mitpress/12643.001.0001
ISBN (electronic): 9780262365970
Publisher: The MIT Press
Published: 2021

The open access edition of this book was made possible by generous funding and support from Arcadia – a charitable fund of Lisbet Rausing and Peter Baldwin



The MIT Press

The open access edition of this book was made possible by generous funding from Arcadia—a charitable fund of Lisbet Rausing and Peter Baldwin.

The MIT Press would like to thank the anonymous peer reviewers who provided comments on drafts of this book. The generous work of academic experts is essential for establishing the authority and quality of our publications. We acknowledge with gratitude the contributions of these otherwise uncredited readers.

This book was set in Adobe Garamond Pro by New Best-set Typesetters Ltd.

Library of Congress Cataloging-in-Publication Data

Names: Wylie, Caitlin Donahue, author.
Title: Preparing dinosaurs : the work behind the scenes / Caitlin Donahue Wylie.
Description: Cambridge, Massachusetts : The MIT Press, [2021] | Includes bibliographical references and index.
Identifiers: LCCN 2020041106 | ISBN 9780262542678 (paperback)
Subjects: LCSH: Science—Social aspects. | Research—Social aspects. | Laboratory technicians. | Museums—Social aspects. | Paleontology—Research.
Classification: LCC QE718 .W95 2021 | DDC 560—dc23
LC record available at https://lccn.loc.gov/2020041106

10 9 8 7 6 5 4 3 2 1