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# AMERICAN SOUR BEERS

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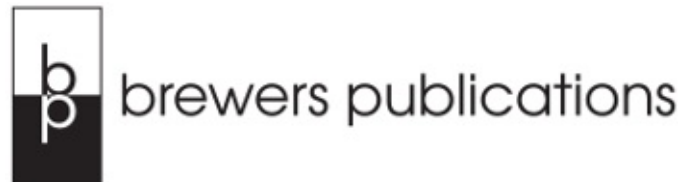
Innovative  
Techniques  
for Mixed  
Fermentations

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# **AMERICAN SOUR BEERS**

Innovative Techniques for Mixed Fermentations

**MICHAEL TONSMEIRE**



Brewers Publications

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To my wife Audrey, my parents Joan and Bob, and a series of understanding roommates who tolerate my filling the freezer with hops, the closet with malt, the basement with barrels, and the air with the smell of fermentation.

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# ACKNOWLEDGMENTS

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Those of us hooked on brewing sour beer know that it is more than just something enjoyable to drink; it is a passion that mandates a level of patience few hobbies or vocations require. It necessitates years of waiting as an idea slowly emerges into the physical. I am not a religious person, but if there were a god I imagine it to be something like a brewer: setting conditions that yield pleasing results. There is no way to tend to the needs of any individual microbe among the hundreds to untold billions that toil and die in the production of a mixed-fermentation beer, but in return for providing them with a suitable ecosystem the brewer is rewarded with a symphony of flavors that no single species of microbe could produce on its own.

Writing this book has motivated me to research aspects of sour beer production that I would not have otherwise. It forced me to organize my thoughts and opinions in a way that blogging rarely does. I was overwhelmed by the openness of American brewers, many of whom offered detailed information and candid anecdotes unprompted. Several mentioned the generous assistance that other brewers had provided to them when they were starting to brew sour beers. I got a real sense of community, despite the fact that it was often my first time talking to them. I appreciate how lucky I was to gain insight in one hour that had taken these pioneers five, ten, or fifteen years to refine. I hope, as some small compensation for their time, this book provides these brewers and their exquisite beers with well-deserved attention.

I am thankful to the brewers who inspired me with their beers and answered patiently almost every question I asked: Will Meyers, Scott Vaccaro, Ryan Michaels, Gerard Olson, Terry Hawbaker, Ron Gansberg, Tomme Arthur, Ron Jeffries, Jeff O'Neil, Pat McIlhenney, Scott Smith, Eric Salazar, Lauren Salazar, Peter Bouckaert, Tyler King, Patrick Rue, Todd Haug, Jason Perkins, Shaun Hill, Brian Strumke, Gabe Fletcher, Bob Sylvester, Alex Ganum, Chad Yakobson, Jason Davis, Jeff Stuffings, Caleb Staton, Tim Adams, Kristen England, Remi Bonnart, Sebastian Padilla, Levi Funnell, Seth Hammond, and Dave and Becky Pyle.

Vinnie Cilurzo deserves special recognition. He personally answered the first question I e-mailed him about the generic Russian River e-mail about sour beers on June 30, 2008 (I was planning on adding plums to my Flemish pale ale at the time). I could never have dreamed that nearly six years later he would be writing the Foreword to my book about American sour beers. Drinking my first bottle of Russian River Supplication in 2005 was one of the experiences that got me hooked on sour beer in the first place. The level of innovation and openness Cilurzo displays continues to impress me.

I appreciate the effort expended by my two technical editors, Yvan de Baets and Jennifer Talley, and publisher Kristi Switzer. Together they did a wonderful job catching my mistakes, debating the finer points of sour beer production, and ensuring this book would not only be technically accurate but also helpful to brewers (craft and home alike). I also want to thank my friends and co-conspirators who filled barrels, inspired me with their homebrews, and shared bottles of sour beers obtained through travel, trade, and tribulation: Nathan Zeender, Alex Howe, Scott Wise, Noah Paci, Tim Pohlhaus, Jeff Long, Zach Brown, Dan Fogg, Eric Denman, Nate Shestak, Dyan Ali, Devin Miller, Dan Fromson, Tammy Tuck, Matt Humbard, and Peter Kay. Without them this would have been a much blander and lonelier adventure.

Thanks to the whizz-bang information superhighway, I was able to sift through a glut of content about each brewery before I talked to the brewers themselves. This preparation allowed me to target my questions, and not waste anyone's time (I hope). This was largely thanks to the podcasters and

beer writers who posted interviews, presentations, and other material, especially: James Spence, Randy Mosher, Jeff Sparrow, Tim Webb, Stan Hieronymus, Steve Gale, Kai Troester, Jeff Beare, Greg Weiss, Aschwin de Wolf, Adam Nason, Brandon Jones, Justin Crossley, Jon Plise, and Jamie Zainasheff.

The brewing books I value the most are tattered, with dog-eared pages and wort stains from brew day referencing. I can only hope that this book becomes one of those on your shelf. Even as I was writing, I found myself returning to reread sections when planning batches or answering questions (which gives me hope).

The next step in my sour beer adventure will be applying what I have learned to commercial production. More than a year after I started researching this book, Jacob McKean hired me to consult for his startup brewery, Modern Times Beer. One of the first assignments he gave me was to help develop the sour beer program. I spent the summer of 2013 growing a huge variety of microbes and inoculate the barrels at Modern Times; hopefully at least some of them will have created delicious beer by the time this book is released. American sour beer has gotten to the stage where it is no longer sufficient to brew something that is “just” sour; beer nerds are becoming beer connoisseurs demanding levels of refinement, balance, and complexity that are challenging to consistently obtain from mixed fermentations. I hope that the brewers at Modern Times and I will be able to rise to that standard, while dealing with the added challenge of me living in Washington, DC while the beers are brewed in San Diego, California.

If you start reading this book before your first taste of sour beer, then I hope you are encouraged to sample a few. If you open this book never having brewed a sour beer, then I hope you are inspired to plan a batch. If you are already a seasoned brewer of sour beer, then I hope that these pages are able to answer questions and spark recipe ideas and process tweaks.

My basement is filled with bottles with various alphanumeric codes scrawled in permanent marker on the caps that allow me to identify what I am opening (I stopped making labels years ago). It is a satisfying feeling to go into the small temperature-controlled basement room to retrieve a bottle filled with beer brewed years earlier. It gives me a chance to reflect on where I was when I brewed that beer and what has happened in my life (brewing and otherwise) since then.

I wish you as much luck on your journey as I have had so far on mine!

# FOREWORD

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American sour beers are something I started dabbling with in 1999 while working for Korbel Champagne Cellars in the early days of Russian River Brewing Company. I began with just two used Chardonnay wine barrels from a local Sonoma County winery. Since then my collection of wine barrels has grown to over 600. If we had more room I am sure we would own even more. Sometimes I buy or trade beer for barrels when I don't even need them (it does take a lot of great beer to make great wine—ask any winemaker!). Purchasing and collecting wine barrels has become a bit of an obsession, much like your Star Wars figurines or spouse's shoe collection that takes up half the closet. Once you start collecting, you just can't stop!

When I started brewing sour beers there were very few resources like this book. My first barrel-aged beer, called Temptation, was made in those first two Chardonnay barrels that I acquired in 1999. At that time, I only used *Brettanomyces* but no bacteria. (I'm not even sure Korbel knew I was using *Brettanomyces* on the winery property, so we will just keep that to ourselves.) My first rendition of Temptation was one of the earlier examples of a wild beer made in America, but definitely not the first. Although this book focuses on American brewers making sour beer, we are not even close to their experience and, to some extent, wisdom as compared to our fellow brewers in Belgium and Germany who have been making sour beer for a very long time. Let's raise a glass to our friends overseas who have inspired so many brewers around the world.

I feel very lucky to have been at the forefront of the American sour beer movement. At the same time I was learning how to make sour beers, my good friend Tomme Arthur, head brewer (at the time) for Pizza Port in Solana Beach, California, was also starting his journey into the world of sour beers. I remember the many phone calls and discussions we had analyzing different techniques and practices we were either currently using or considering. Thinking back to those early days in brewing always reminds me of all the different hops and hop combinations I discovered early on. It was all a bit overwhelming at the time, but eventually I learned which hops I preferred for bittering and which ones I preferred for aroma. Learning about sour beer production was easily just as intimidating, if not more so.

In 2005 our first batch of Beatification was already in barrels. This batch would end up being the only batch of Beatification into which we pitched yeast and bacteria. All subsequent batches would end up being a blend of what we called Sonambic, our own version of a spontaneously fermented beer. That same year, on a flight home from Belgium, Tomme Arthur and I were discussing everything we had learned the previous week. He brought up the idea of first making a sour mash in the mash tun and then the following day use the mash tun as a horny tank (after the spent grain is removed) to start collecting some wild yeast and bacteria. This is an alternative for those brewers who do not possess a coolship. The wort from that first batch of Sonambic sat in the mash tun overnight and by the next morning, to my surprise, it was fermenting. Once I got it into barrels the batch kept fermenting—bungles were popping out, and beer was spilling all over the place in our barrel room! It was a beautiful sight. We eventually stopped using our mash tun for this purpose and now Sonambic is made in our own version of a horny tank. It is much deeper than a traditional coolship and the shape is not something you would see in Belgium. But, we had to make it work in the space we had available. The spirit of spontaneously fermented beer is now alive and well right here in Sonoma County, California.

This book is a snapshot in time of the current landscape of New World sour beers. Like any good sour beer, the techniques and wisdom of brewers will definitely change over time. I sat on a barrel

beer panel at the 2004 Craft Brewers Conference in San Diego, California. At the time, I was advocating for production procedures that are very different from what we now do at Russian River. There was nothing wrong with what I once did, but my thought processes and procedures have evolved over time. In the 15 years I have been experimenting with sour beers I have learned a great deal primarily from trial and error. But much of my education has come from sharing experiences with other brewers, as well as learning from those who have been brewing these beers for generations. Early on in the learning process we overcarbonated a batch of Temptation bottles. We had to uncork all of the bottles in order to release some CO<sub>2</sub>, then recork each one. We did this process by hand for several times to over 3,000 bottles before finally adding a new wire hood. Fortunately, it worked and we were able to sell all the beer. That money was likely needed to make payroll back in the early days!

Then there was the time when our first bottled batch of Sanctification (100% *Brettanomyces* beer) formed a pellicle in the neck of the bottle. At the time I had no idea what a pellicle was or what caused it. Then there was our first batch of Compunction, a sour beer aged in barrels with pluots. The first and only time we bottled it, in 2006, I mistook what turned out to be a collection of pectin and other fruit by-products for yeast sediment. In the end there was two inches of sediment in each bottle. The damage was done and we ended up opening all the bottles and dumping them into a tank. Our bottling equipment in those days could not handle carbonated beer, so we ended up filtering it and putting it in kegs. Naturally, Compunction is now available on draft only. I definitely got schooled in the fine art of bottling sour beers and the potential for bizarre results!

While on this funky/sour beer journey, we have created our own process that I like to refer to as the “Russian River Way.” My hope is that the technical components and artistry documented throughout this book, along with the real world examples, will inspire you to create your own funky beer-making process. If you are willing to make mistakes and learn from them, you will become a better brewer.

For those of you who are just starting to get “funky,” have patience. Use this book to help guide you through this fun and often unpredictable journey. You will quickly learn that sour beers are less about traditional styles and more about “liquid art.” Sour beers are the ultimate 10 minutes of drinking pleasure (to paraphrase a quote from Peter Bouckaert). Do not concern yourself right away with all the nitty-gritty details. These will come to you over time. Sometimes having all the information upfront makes you try too hard to control something that really needs to develop a style and technique all its own. That was certainly the case for me. On occasion I would reach out to Peter Bouckaert at New Belgium Brewing Company for advice. In typical Belgian brewer fashion, he never gave me a complete answer, only bits and pieces. I would have to figure the rest out on my own. This limited but useful guidance was essential in helping me develop my own systems for making sour beers. For this I am grateful.

This book will also be very useful for those who are already producing sour beers. I’m certain this will be a great reference book to add to your library. I found good nuggets of information, both artistic and technical. I am definitely inspired to brew some new sour beers at our brewery.

Above all, never lose respect for the bugs and critters it takes to make these beers. Cross-contamination is a real threat and not that uncommon. I strongly recommend you pay close attention to [Chapter 2](#) of this book, and specifically the safety and sanitation part of this chapter. There are many pitfalls you can avoid with a little planning ahead of time. The great beer writer Michael Jackson once compared *Saccharomyces* to a dog and *Brettanomyces* to a cat. *Saccharomyces* is trainable and mostly predictable. Conversely, *Brettanomyces* may, like a cat, run away when you call for her, or scratch you when you pick her up. But sometimes the cat decides to love you and show great affection. It’s all about respect. If you have a healthy respect for *Brettanomyces* (as well

bacteria) and the havoc it could wreak in your brewery, you should remain unscratched.

Grab a bottle of your favorite sour beer and get started on your wild journey into the world brewing funky beer with this helpful book as your guide!

Cheers,

Vinnie Cilurzo

Russian River Brewing Company

# INTRODUCTION

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*You know all those brewers who like to be called Master Brewer? For me a lambic brewer is never a Master Brewer, because a master is someone who dominates the product. We never dominate the product.*

—Jean Van Roy (fourth-generation brewer/owner of Brasserie Cantillon)<sup>1</sup>

In Belgium, brewing and blending *lambic* is regarded as a nearly mystical skill that requires secret knowledge usually passed from father to son. The name of the Belgian brewers' guild is the Knighthood of the Brewers' Mash staff,<sup>2</sup> which gives an indication of how insular they are. They can be mischievously misleading when answering questions from the uninitiated, closely guarding their inheritance. Brewing *lambic* relies on spontaneous fermentation with wild microbes, predating the study of microbiology and making it more art than science. *Lambic* brewers who stray from traditional methods tend to do so to the detriment of the beer, diminishing a fascinatingly tart beverage into a sugary alcopop.

American craft brewers have built their industry by combining and adapting brewing techniques and recipes from all over the world. They often begin their careers brewing reliable ales and lagers, and as a result come to expect a high degree of control over the brewing process. Sour beer resists taming but this has not stopped American brewers from developing distinctive methods suited to their particular tastes and constraints. Competing in a marketplace dominated by a handful of megabreweries has also fostered an open and collaborative culture among their small and independent brethren.

My own journey into sour beer began with Jason Steingisser, a childhood friend, who introduced me to “good” beer shortly after my 21st birthday. He and I were home in Massachusetts for the summer before returning for our senior years in St. Paul and Pittsburgh, respectively. At the time I did not have a cerebral interest in beer because I understood the term to refer exclusively to bland, overcarbonated pale lagers. After tasting the range between beers like Ommegang Hennepin and Dogfish Head India Brown Ale, I made it my mission to sample every style. Luckily, back in Pittsburgh, I discovered Dog SixPax & Dogz, a bar that stocked a huge variety of single bottles that could be purchased to go (Pennsylvania beer distributors on the other hand are required to sell beer by the case). I went to work consulting website reviews to find a well-regarded example of each style.

When my quest arrived at fruit *lambic* I picked the least expensive, Lindemans Kriek. It was slightly tart, but the primary flavors were fruity and sweet. While certainly drinkable, it was not nearly as sour as I expected from descriptions of *lambic*. A few weeks later I splurged on a 375 ml bottle of Cantillon Kriek 100% *Lambic*. The acidity was bracing; over the two hours it took me to consume the bottle, all I could do was wonder why anyone would choose to drink something so sour. There was something there though. Maybe it was the challenge, or those long neglected neurons that had not fired since my sister and I competed to see who could keep blue raspberry Warheads<sup>®</sup> in their mouth the longest. From that point on, every few months I sampled a new sour beer. As my tongue gradually acclimated to the acidity of *gueuze*, Flemish red, and Berliner *weisse*, I began to perceive other complex and surprising flavors that had been previously hidden.

During my senior year at Carnegie Mellon University I brewed my first two batches of homebrew with my friend, Nicole Yeager, as part of a student-taught class, “Beer Brewing and Appreciation.”

While I was starting to enjoy sour beers, as a college student it was a rare treat at 10 dollars or more for a bottle.

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After reading Jeff Sparrow's seminal *Wild Brews: Beer Beyond the Influence of Brewer's Yeast* (Brewers Publications, 2005), I knew that brewing a sour beer was something I had to attempt. At first I was hesitant, because the owner of my local homebrewing shop warned me that doing so would risk turning all of my batches sour. I even read online that I would need to store the fermentors of sour beer in a separate room away from all of my other fermentors, lest the microbes from an *oud bruin* might take to the air to invade an IPA. My excuse finally came a year later during a summer preceding a move to Washington, DC for a new job. During that time I brewed four batches of sour and funky beer (Belgian-style lambic, Flemish red, Belgian strong dark with cherries, and old ale with *Brettanomyces*) to leave aging at my parents' house. Over the next year, every time I returned to Massachusetts I would pull a sample from each of the carboys. When the beers were ready, I bottled them and drove the cases back to DC. The results were pleasant, except for the Belgian-style lambic and I was hooked. Since then I have continuously experimented, fermenting batches of beer with microbes other than brewer's yeast and writing about my experiences on my blog, *The Micro Fermentationist*.

Why would I write this book when there are already a number of other great books that delve into sour beers? These include, among others, Sparrow's *Wild Brews*, Jean Guinard's *Lambic*, Classic Beer Style Series 3 (Brewers Publications, 1998), Randy Mosher's *Radical Brewing* (Brewers Publications, 2004), and Stan Hieronymus' *Brew Like a Monk* (Brewers Publications, 2005) and *Brewing with Wheat* (Brewers Publications, 2010). After years of researching recipes and blog posts I realized that although some of what I was seeking was spread among these books, there remained a large range of techniques, ingredients, and recipes for American sour beer production that were not covered. This is a developing field, and American brewers, both home and commercial, are pushing the envelope with experimentation with these styles. I wanted to write a book that would provide actionable advice for producing innovative American sour beers with the details in one place.

I set out to write about my own methods and experiences, but the openness of the two-dozen American brewers I interviewed allowed me to write a book with a wider scope than originally intended. Nearly every one of the brewers I contacted were willing, and often excited, to share the granular details of their process. Several of them mentioned that the only reason they had been able to successfully produce sour beers so quickly was the openness of other brewers. Talking to these brewers, many of whom have now been brewing sour beers for a decade or longer, allowed me to document the distinct production methods that each has developed.

This book does not cover the basics of wort production, brewer's yeast fermentation, or sanitation. If you cannot already brew a solid clean beer, this book will not be that useful. My goal is to give brewers who can already brew ales and lagers the information they need to adapt their process to produce sour, funky, and wild beers. If you are not at that point yet, read John Palmer's *How to Brew* (Brewers Publications, 2006) or Wolfgang Kunze's *Technology Brewing and Malting* (VLB Berlin, 2010) and refine your wort production and fermentation skills on beers that have faster turnaround times.

Brewing sour beer depends on experience, feel, and instinct. This book lays out options, differing opinions, and general concepts that you will need to come to your own decisions about. After reading it you should be able to brew a solid sour beer on your first try. However, the skills required to consistently brew superb sour beers cannot be learned solely by reading or observing. Becoming an expert takes years of practice honing your method and training your palate.



# About This Book

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We begin with an overview of the history of sour beer in [Chapter 1](#). Sour beer is not a modern concept; acidity has been a component of beer's flavor for most of the beverage's history. By the 1980s that tradition had been nearly extinguished by revolutions in pure yeast culturing and sanitation a century earlier, but since then sour beers have experienced a resurgence that continues to accelerate. This chapter includes some background on the current state of mixed-fermentation in Belgium, Germany, Great Britain, and America as well as some suggested beers to sample from each nation. I do my best to describe the hundreds of beers mentioned in the book, but drinking them yourself will make this book much more useful.

[Chapters 2, 3, and 4](#) provide the basic information that the later chapters will draw upon. [Chapter 2](#) aims to get you into the sour beer mindset, answers some basic worries that prevent many brewers from attempting sour beers, and presents a straightforward method for brewing your first sour beer. [Chapter 3](#) also covers important safety and sanitation information and considerations. The remainder of the book is laid out to follow the path a sour beer takes from brew day through drinking. Wort production is the focus of [Chapter 3](#). It covers malt and hop selection, water treatment, and mashing techniques. Once your wort is produced you will need to select what strains of lactic acid bacteria and yeast you want to pitch into it. [Chapter 4](#) contains descriptions of the contributing species of microbes. This chapter also covers techniques for growing and maintaining your own cultures, and obtaining microbes from places other than yeast laboratories.

There is much more variability in the methods used to produce sour beer than most other styles. Many different styles of clean beer are produced with the same basic process, simply by varying ingredients, mash temperature, and fermentation temperature. When it comes to sour beer there are dozens of different methods. [Chapter 5](#) starts with profiles of the general approaches used to produce the four surviving styles of European sour beer. Following that are profiles of American sour beer innovators, including the souring method employed by each. If you have a favorite sour beer producer, read the description of their method, microbes, and ingredients and consider which elements you would like to adopt.

While homebrewers should borrow elements from their favorite commercial producers, not all the processes and equipment are transferable to small volumes. Because of this, I profile three complete methods tailored to brewing on a small scale in [Chapter 6](#). Some of these techniques may also be valuable for craft breweries that are looking to tinker with sour beers without committing to large volumes.

[Chapter 7](#) deals with an Old World tradition that has gained new followers in America: spontaneous fermentation. This is allowing truly wild microbes from the air to ferment your beer, as is done with traditional lambics. One of the riskiest and most rewarding ways to brew a sour beer, spontaneous fermentation is already producing some remarkable beers in states as far apart as Maine, Michigan, and California.

After a chapter about American brewers borrowing from the past, [Chapter 8](#) covers the American innovation of fermenting beer with nothing but *Brettanomyces*. This so-called wild yeast provides most of the characteristic flavors and aromas of sour beers, other than sourness. If you treat it as you would ale or lager yeast, *Brettanomyces* can produce a wide range of fantastic flavors in a relatively short period of time.

[Chapter 9](#) is all about fermentors and wood. While the flavor contribution and use of barrels is a subject that deserves its own book, I cover the basics. The use of oak barrels is ingrained in the history

of sour beer. They provide complementary flavors, a home for the microbes, sugars for them to ferment, and a slow but steady supply of oxygen for their use. While many American brewers have joined this tradition, others opt to ferment their beers in impermeable fermentors with oak cubes which can produce excellent results as well.

Having covered all of the angles for producing and fermenting sour beer, [Chapter 10](#) delves into the ways in which these beers can be flavored with fruits and vegetables. Ranging from the most traditional, sour cherry, to the borderline crazy, chile pepper, this chapter covers many of the options available in terms of variety, form, and timing.

[Chapters 11](#) and [12](#) cover how to finish the brewing process, regardless of how the beer was soured or flavored. Blending and aging is covered in [Chapter 11](#). This may not sound like the most exciting subject, but it is possibly the most important. More than anything else, brewing with blending in mind and possessing an experienced palate to match and adjust beers, is the secret to producing consistent, terrific sour beers. Packaging, dealt with in [Chapter 12](#), is a similarly overlooked aspect, but for anyone who has opened a bottle of sour beer that was either dead-flat or gushed, you know how a mistake here can ruin an otherwise perfect beer.

The shortest chapter, and hopefully one you will not need to reference frequently, is the troubleshooting guide in [Chapter 13](#). I have covered the most common flavors and appearances that alarm brewers when making sour beer. In many cases there are solutions, which often involve just waiting, but it is also valuable to know when it is time to cut your losses and dump a batch. If you are worried about a sour beer you are brewing or have a question that this book does not address, please feel free to contact me through [www.TheMadFermentationist.com](http://www.TheMadFermentationist.com).

Finally, we reach recipes in [Chapter 14](#). I did not include any recipes I have not brewed myself. Recreating a commercial sour beer is a nearly impossible task, even if you have a brewery's exact recipe. As a result, I only included recipes that were inspired by innovative commercial beers, all of which I have actually brewed. If you enjoy the character of a particular brewery's beer it is much more valuable to look at their process and where they source their microbes, rather than mimicking the grain or hop bill. Still, it may be helpful to look at some of the beers I have brewed for inspiration and to get a complete picture of how all of the pieces fit together. Each recipe includes some suggested variations, but in most cases it is best to let your palate guide your choices.

## References

1. Jean Van Roy, interview with Tim Webb, *Beer Amongst the Belgians* promotional video, produced by Taylor Brush for Spotted Tail Productions, available as Vimeo video, April 30, 2012, <http://vimeo.com/41276710>.
2. "The Knighthood of the Brewers' Mash staff," Belgian Brewers, last accessed December 16, 2013, <http://www.belgianbrewers.be/en/beer-culture/the-knighthood-of-the-brewers-mash>.

# SOUR BEERS: A PRIMER

Before digging into the specific details and variations that the rest of this book contains I want to ensure that you have a basic understanding of sour beers. A short introduction to the history of sour beers, some terminology, and cultural exploration will provide a foundation for the remaining chapters.

## A Brief History of Sour Beers

Beer was invented (or should I say discovered?) at least 9,000 years ago.<sup>1</sup> However, the grain-based intoxicants enjoyed for most of the subsequent nine millennia would hardly be recognizable to most beer drinkers today. It was only 500 years ago that hops became the default seasoning, and it was just 150 years ago that wort was first pitched with isolated strains of brewer's yeast. Without the antimicrobial properties of the hops, and before the use of sterile culturing techniques, all beer would have begun to sour within days or weeks of brewing. In modern America, to receive label approval from the Alcohol and Tobacco Tax and Trade Bureau (TTB) a beer is legally required to contain hops and until the 1990s beers fermented with anything other than brewer's yeast had all but slipped from collective memory.

Historically, the complex flavors of well-aged mixed-fermentation beers were appreciated. In England brewers allowed high-alcohol beers to “stale” in oak barrels, where they developed tartness and unique flavors from the resident microbes before being blended with young beer. German and Belgian brewers developed beers known and loved for their acidity, like Berliner *weisse* and *lambic*. However, as the industrial revolution took hold during the latter half of the 19th century, brewers looked for ways to hasten production and consumers increasingly demanded clean and consistent “modern” beers. Thanks to Louis Pasteur's revolutionary *Studies on Fermentation: The Diseases of Beer, Their Causes, and the Means of Preventing Them*,<sup>2</sup> brewers were able to do away with continually repitching mixed house cultures in favor of selecting a single strain of yeast. Brewing scientists later discovered that, while wild yeast and bacteria were responsible for spoilage, some were responsible for those coveted “stale” and tart flavors of aged beers.<sup>3</sup>

Even after most brewers adopted pure yeast strains, tart mixed-culture fermented beers survived and in some places thrived. The immigrants who flooded America after the Civil War brought with them their taste for the local beers of their homelands. So at the same time that breweries like Pabst Brewing Company (San Antonio, TX) and Anheuser-Busch Brewing Company (St. Louis, MO) were coming to dominate the market with pale lagers from Munich and Prague, other brewers in places like Baltimore specialized in tart Berliner *weisse*.<sup>4</sup> There were even American brewers who specialized in English-style tart, oak-aged stock ales.<sup>5</sup> In spite of that, because of their relatively small size, none of the American breweries producing sour beer survived the US government's 14-year prohibition of alcohol. In the years immediately following the repeal of Prohibition there were traces of sour beers like the “Lambic Lager Beer” brewed by Peter Doelger Brewing Company in New Jersey,<sup>6</sup> but I have not found any evidence that names like this were anything other than marketing. Luckily for Americans there were a few holdouts in other countries, places like Berlin and the Senne Valley, where a handful of historic sour beers were sheltered long after they died out elsewhere.

Since the 1970s American consumers have become increasingly interested in the flavor and

tradition behind what they eat and drink. Beer was only one of many edible and potable commodities that had become increasingly homogeneous in modern times. As demand slowly swelled for cheeses more complex than Kraft® American Cheese, and loaves chewier than Hostess Wonder Bread®, so did for more interesting styles of beer.<sup>7</sup> While consumers were originally attracted to German lagers and English ales, eventually small importers like Shelton Brothers, Vanberg & DeWulf, and Merchandise du Vin began importing bottles of many of the surviving European sour beers. Years of limited choices provided good beer with something it rarely had before—cachet. Even in Belgium, many of the most traditional and eccentric producers are only able to survive because their beers are sold at much higher margins in countries like America and Japan than is possible in their home market.<sup>8</sup>

In the mid-1990s, as American craft brewers began to master and then adapt many of the traditional beer styles from around the world, there were only a few brewers who started to dabble in sour beer. As recently as the late nineties, no more than a handful of craft brewers were experimenting with microbes other than brewer's yeast. One of the first commercial sour beers to be brewed in America post-Prohibition was by Kinney Baughman of Cottonwood Grille & Brewery, in 1995. The brewer released two sour beers, Belgian Amber Framboise and Black Framboise, created by blending clean beers with a batch accidentally contaminated with the lactic acid bacteria *Pediococcus*.<sup>9</sup> A few years later in 1999, New Belgium Brewing became the first American brewery to release a world-class sour beer with the first bottling of La Folie. Making a beer that stands shoulder-to-shoulder with the best Flemish reds is a major accomplishment, a result achieved in no small part thanks to the time New Belgium's brewmaster, Peter Bouckaert, had spent in the same position at Brouwerij Rodenbach in Belgium.

It was not until 2002 when the Great American Beer Festival® (GABF), already in its 21st year, introduced its first sour beer category. That year, out of only 15 entries, it was no surprise that La Folie won first place, especially considering it had won the more competitive Belgian- & French-Style Specialty Ales category the previous year. Since then the bar has been raised, as breweries such as Russian River Brewing Company, Jolly Pumpkin Artisan Ales, and the Lost Abbey, not forgetting New Belgium as well, have released sour beers that strike off in directions all their own: aged in fresh wine and spirit barrels; flavored with dry hops, local fruits, and spices; and brewed with more assertive malt bills. By 2013 the GABF had taken those beers that had moved beyond pure brewer's yeast fermentation and split them into five separate categories, with a total of 238 entries.<sup>10</sup>

Today it can sometimes appear as though every American craft brewer has released a sour beer, but the required investment in time and space means that few of these brewers devote a large portion of their production to them. The attractive margins and high demand that sour beers command will continue to entice many brewers to increase production.

The yeast and bacteria responsible for sour beer fermentation are capable of producing complex combinations of flavor compounds that cannot be obtained in any other way; because of this so many sour beers currently enjoy something of a cult status. The flavor profiles of these beers range from simple and quenching to complex and meditative.

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## Sour Beer Terminology

Here are definitions for seven basic terms used throughout the book to describe flavors and aromas found in sour beers:

**Acetic acid.** Acetic acid is the same acid found in vinegar. It is sharper than lactic acid and the taste

perceived farther back on the palate. This acidity is complementary in small quantities, where it adds a more assertive, sharper sourness, but it can be unpleasant at elevated levels. It is most closely associated with Flemish reds, but it also plays a small role in many other sour beers. Acetic acid is produced by either the bacteria *Acetobacter* or the yeast *Brettanomyces*, in both cases only in the presence of oxygen. The TTB limits acetic acid levels, indicating it should be no more than 0.15% of beer.<sup>11</sup>

**Clean.** Beers that are not sour or funky, that is to say those fermented with a pure culture of brewer's yeast (i.e., *Saccharomyces cerevisiae* or *S. pastorianus*), are described as “clean.” This category covers a great majority of the beer commercially brewed today.

**Esters.** Esters are molecules formed by the combination of an acid and an alcohol. Both brewer's yeast and *Brettanomyces* have the ability to create esters, but only *Brettanomyces* can break them down. Belgian ale yeast strains are prolific ester producers, while one of the goals of lager brewing is to minimize ester formation. The esters we are concerned with in beer are aromatically fruity. The aroma may not only be reminiscent of a particular fruit but also chemically identical to an ester found in that fruit. For example, the isoamyl acetate produced in German wheat beers is also found in bananas.<sup>12</sup>

**Funk.** Funk describes a wide range of flavors and aromas not present in beers fermented with *Saccharomyces* alone. Common sensory descriptors include barnyard, horse blanket, and dank basement. Among the various types of molecules that contribute to “funkiness,” phenols are of particular interest because of the wide range of sensitivity of beer tasters.<sup>13</sup> As a result, a sour beer that is pleasantly “farmyardy” to one drinker may be reminiscent of a Band-Aid® to another.

**Lactic acid.** Lactic acid is the same acid found in yogurt, buttermilk, and other soured dairy products (hence its name). Not as sharp as acetic acid, lactic acid has a soft, tangy flavor, although this can become lip-puckeringly sharp at higher concentrations. Lactic acid is one of the primary acids found in sour beers, alongside carbonic acid from dissolved carbon dioxide. It is produced by lactic acid bacteria, specifically species of *Lactobacillus* and *Pediococcus* in the case of beer.

**Sour.** One of the basic tastes perceived by taste buds is sour. It is described as tart, acidic, tangy, and salivary gland-stimulating. Sour should not be confused with bitter. All beers have a pH below neutral (pH 7) and are thus technically acidic, but only a small percentage have a pH low enough to truly taste sour.

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## Classic Commercial Examples of Sour and Funky Beers

All over America stores are opening or expanding their offerings to cater to beer enthusiasts. Most carry at least a few sour beers. Exposure to a rich array of sour beers is the only way to determine which flavors you enjoy and which ones you find unpalatable. This “research” is a crucial first step in brewing beers that suit your taste. You cannot select the optimal ingredients or techniques until you have determined what balance or character you are aiming for in your beer.

Take the opportunity to sample in small quantities at better beer bars, high quality beer festivals (e.g., GABF, Great Taste of the Midwest, and those sponsored by Beer Advocate), or with friends. Festivals are often the best places to taste hard-to-obtain and experimentally soured batches. Keep

tasting notes for the beers you sample, especially if you are attending a festival that has brewers on hand to answer questions. Pay attention to the flavors you enjoy and which breweries you gravitate toward. Try sampling a few similar beers from different breweries side-by-side to accentuate the differences.

If you are new to drinking sour beer, what follows is a brief overview of the traditions and beers of Belgium, Germany, Britain, and the US. Many cost less than 10 dollars a bottle, but even the most expensive examples are a worthwhile investment before embarking on the lengthy souring process yourself. As with all of the beers mentioned in this book, the descriptions below are a snapshot as of the writing of this book. Recipes, microbes, and processes change, and beer flavors evolve.

## Belgium

Sour beer is most closely associated with the Belgian brewing tradition. This small nation—nestled between France, Germany, the Netherlands, and Luxembourg—is home to the sweet and sour red and brown ales of Flanders, and the sharp lemony lambics of the *Pajottenland*. In addition to the beers that fall into the classic styles, the country is also dotted with a plethora of tiny breweries making acidic and funky beers all their own. Despite its size, Belgium produces a greater variety of beers than any other European country; their brewers simultaneously hold a reverence for tradition and a passion for experimentation. Even several of the most ardently traditional lambic producers brew experimental batches with nontraditional fruits, spices, and barrel aging techniques.

What follows are some classic examples of Belgian beers:

**3 Fonteinen Oude Geuze (Beersel, Brabant).** This *gueuze* (blended and carbonated lambic), is bright and complex, with lemon, mineral, and classic farmyard funk. It is nicely balanced and not as acidic as some other examples of *gueuze*. It improves with age, so jump at any opportunity to drink a bottle that is a few years old. If you get your hands on a bottle marked “Vintage,” consider yourself lucky because these are blended from owner Armand Debelder’s favorite barrels.

**Cantillon Kriek 100% Lambic (Anderlecht, Brussels).** Sharply acidic, with enough cherry to let you know it is a fruit beer, but not so much as to mask the rest of the base beer’s funky complexities. While sour cherry is the most common fruit added to lambics (and sour beers in general) many of Cantillon’s other releases venture away from the norm. Also worth seeking are Saint Lamvinus (red wine grapes), and Fou’ Foune (apricots).

**De Dolle Oerbier Special Reserva (Esen, West-Flanders).** A fantastic strong, dark sour beer. One of the most complex beers I have tasted; the best bottles have flavors of port, leather, blue cheese, and rich malt. Try it next to the standard Oerbier to get an indication of the change that microbes and barrel aging can induce in an already marvelous beer. The strain of *Brettanomyces* used in the Special Reserva was originally cultured from a keg of beer that was returned to De Dolle years after it was initially sold.<sup>14</sup>

**Orval (Florenville, Luxembourg).**\* The only widely distributed beer from the Trappist monastery of the same name (Abbaye Notre-Dame d’Orval), this pale beer is so synonymous with *Brettanomyces bruxellensis* that people refer to horse blanket and farmyard aromatics in other beers as “Orval character” (*goût d’Orval*). Orval is hoppy when fresh, growing drier and funkier as the years pass.

**Rodenbach Classic (Roeselare, West Flanders).** The embodiment of Flemish red. It has a malty sweetness, but not so much that it tastes sugary or artificial like some Flemish reds. Sweetness in a bottled sour beer can only be preserved by pasteurization or filtration. Rodenbach’s beers display

varying levels of acetic acid character, which gives them a different, more vinegary acid profile than most other sour beers. Rodenbach Grand Cru contains a higher percentage of wood-aged beer than Rodenbach Classic, and as a result is reminiscent of good balsamic vinegar.<sup>15</sup>

Note: If you are interested in the history and evolution of these styles, I recommend you read Jesse Sparrow's *Wild Brews* and Webb, Pollard and McGinn's collaborative effort, *LambicLand: A Journey Round the Most Unusual Beers in the World*.

## Germany

Despite the legacy of the rigid *Reinheitsgebot* (beer purity law) and its brewers' renown for clean lagers, Germany has a rich tradition of sour beer production. Berlin's low-alcohol wheat beers and Leipzig's salt and coriander-enriched Gose are the only two surviving styles, with others still waiting to be revived. German sours tend to be more restrained than the Belgian examples, relying on *Lactobacillus* for sourness and mostly forgoing the complex earthy funk of *Brettanomyces*. If you are new to drinking or brewing sour beers, German styles are a good place to start because their flavors are more approachable and they take less time to mature.

What follows are some classic examples of German sour beers:

**Bahnhof Gose (Leipzig, Saxony).** The only widely distributed Gose is barely tart, with a refreshing salinity and a pervasive coriander aroma. A resurrection from Leipzig's past, it is not the sort of beer you expect to taste from a German brewery. It was recreated after the style died out in the 1960s, so it is unclear how close it comes to historical examples.

**Berliner Kindl Weisse (Berlin).** This Berliner weisse is the sole remaining Berliner weisse, with a history stretching back to the style's 19th century heyday. It is low in alcohol and possesses a clean tartness. Until recently it was brewed alongside the now discontinued Schultheiss Berliner Weisse (which had a touch of *Brettanomyces*). The closest example to Kindl Weisse that is still exported to America is Bahnhof Berliner Style Weisse, a *Brettanomyces lambicus*-spiked Special Edition that is closer to the more aggressive Schultheiss.

**Professor Fritz Briem 1809 Berliner Style Weisse (Freising, Bavaria).** This relatively new entry to the style has more in common with a sour *hefeweizen* than a traditional Berliner weisse. Its flavor exhibits banana, clove, and bready malt, but also a wonderful lactic acid tartness. At 5% alcohol by volume (ABV) it is strong for a modern Berliner weisse, but is still a unique and delicious sour beer.

Note: Stan Hieronymus's *Brewing with Wheat: The 'Wit' and 'Weizen' of World Wheat Beers* relates the history and traditional production of German sour beers better than I could ever hope to do.

## Great Britain

England and Scotland have a long tradition of *Brettanomyces*-influenced, strong, wood-aged beers, but any true sour beers they once had have completely died out. British ales with funky characters and minimal sourness are the opposite of the tart beers of Germany. If you are averse to sourness then you would be a good place to look for inspiration. There are a handful of British breweries that are brewing sour beers, but they do not have the unbroken lineage of their Belgian and German counterparts.

Below are some examples of classic beers from Britain:

**Gale's Prize Old Ale (Horndean, England).** While Prize Old Ale is transcendent perhaps a quarter of the time, the rest of the corked bottles do not live up to this experience. It is pretty easy to find

vintage bottles at many specialty shops and bars in America, but most fall short of the wonderful leather and damp basement aroma, with flavors more reminiscent of vinegar and musty socks. The one sample I had on cask at a festival still ranks near the top of my favorite glasses of beer.

**Greene King Olde Suffolk (Bury St Edmunds, England).** Olde Suffolk harkens back to the 18th and 19th centuries, comprising a fresh mild beer blended with a strong ale that has been aged for two years in oak. With hints of sherry and oak, the flavor is reminiscent of Gale's Prize Old Ale, but it is more consistent, and only rarely is it either spectacular or "off." I wish they bottled the 5X (aged portion) straight so I could try it, although on occasion the brewery is known to serve it to visitors.

**Le Coq Imperial Extra Double Stout (Lewes, England).** With Courage's Russian Imperial Stout no longer brewed with a mixed fermentation as it once was, Le Coq is the closest you can get to a taste of the high alcohol stouts that were shipped to the czars and czarinas of Russia in the 19th century.

**Williams Brothers Grozet (Alloa, Scotland).** Grozet is a lightly hopped *gruit* flavored with gooseberries. It is a tart callback to the days before hops were the exclusive counterpoint to malt sweetness. Williams Brothers produces several minimally hopped beers (including those flavored with seaweed, pine, and heather), but this is the only one that has perceived sourness.

## United States

Serious commercial sour beer production in America only started again in the 1990s. At first, the pioneering craft breweries mimicked the styles and techniques of Belgium, Germany, and Great Britain, but having found their footing many are brewing unique creations, gradually developing their own aesthetic and methods. The best examples often stray from tradition, with unique barrel characters, fruit additions, and base beers. American sour beers tend to be drier and possess a more assertive acidity than Old World examples.

What follows are some noteworthy examples of American sour beers:

**The Bruery Tart of Darkness (Placencia, California).** Tart of Darkness shows that sour beers do not come in all colors. This tart stout is aged in bourbon barrels with a variety of microbes. The result is a marriage of freshly roasted coffee from the malt, vanilla from the charred oak, and fresh cherries from the *Brettanomyces*. That may sound like a mouthful, but at 5.6% ABV it is balanced and approachable.

**Jolly Pumpkin Bam Bière (Dexter, Michigan).** Bam Bière is low in alcohol, hoppy when fresh, and becomes lightly tart and funky when aged. It is a good beer to search out if you want a gateway to the more aggressive examples. While Jolly Pumpkin's entire production is comprised of barrel-aged sour beers, their beers tend to be among the most approachable.

**New Belgium La Folie (Fort Collins, Colorado).** The original king of American sour beers, La Folie is at its best when the acidity is potent, with a vinegary sharpness balanced by caramel maltiness. The unpasteurized corked and caged bottles tended to be more complex and aggressive, while the "Lips of Faith" series available in 22 fl. oz. "bombers" are more approachable.

**Russian River Supplication (Santa Rosa, California).** This brown ale starts with a firm, rounded sourness, followed by distinct dried cherry taste, and finally red wine from the Pinot noir barrels the beer is aged in. All of Russian River's sour beers manage to be both complex and balanced.

The beers described above (and many like them) are the focus of this book. Methods used by American brewers are more applicable to both homebrewers and commercial breweries planning to embark on brewing their own sour beers.



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