QUESADA/BURKE STUDIOS

The Mystery of Lambic Beer

An ancient brewing technique produces a beverage so complex that it is still yielding its secrets to organic chemists

by Jacques De Keersmaecker

Over the past 2,000 years, the region that is now Belgium has been one of the most heavily trafficked crossroads of Europe. In 57 B.C. the territory, occupied by Celts, was invaded by the Romans and later by Normans. Throughout the centuries, a veritable parade of rulers came and went, including (after the Romans) the Merovingian Franks, the Germans, the Dutch, the Burgundians, the Austrians, the Spanish, the French and the Dutch again. From each of them came the threads, patterns and cloth that created the rich tapestry of Belgian culture, with its diverse contributions to art, cuisine and, not incidentally, brewing.

Some historians suspect that one of these subjugators, possibly the Romans, brought to the region a brewing process that may already have been ancient when it began flourishing around Brussels many centuries ago. During this process, brewers exposed their concoction to the air, causing it to be seeded (or, more accurately, inoculated) by whatever wild, wind-borne yeasts happened to drift in. Only within a roughly 500-square-kilometer area around Brussels and in the Payottenland, a valley of the Senne River on the west side of the city, did the right mix of airborne spores ensure that this spontaneous fermentation occurred consistently. Like Brussels itself, the brewing style thrived amid fields, orchards and woodlands and was nurtured by them.

Centuries later, what is regarded as the oldest surviving commercial brewing style still produces many of the same beers in essentially the same way. This diverse family of beers, known as lambic, includes tart but smooth members, older specimens that are full of complex character, and sweeter fruit- or cane-sugar-flavored varieties. In the better examples is an earthiness—a faint, slightly musky remnant of their wild origin that often comes as a surprise even to jaded beer connoisseurs.

It is likely that all beer was once spon-

HIGHLY AROMATIC LAMBICS are always served, in their native Belgium, in glasses designed to convey their aromas. Fruit lambics, such as cherry, peach, raspberry and plum, are usually poured into snifters or flutes. More traditional gueuze and faro are often served in tumblers.

taneously fermented, like lambic, with wild yeasts only. A brew called *sikaru,* for instance, was produced 5,000 years ago by Sumerians in Mesopotamia. Instead of hops, of which they had no knowledge, Sumerians flavored their brew with spices such as cinnamon. Over the centuries, most of the world's brewers began using techniques that minimized and eventually eliminated the effects of wild yeasts, culminating in the 19th century with the use of scientifically isolated yeast cultures. Fermentation became more efficient and predictable. Through all this, lambic has endured, a throwback to brewing's splendidly eccentric roots.

In 16th-century Belgium, lambic beer soon became a staple of social life. In many paintings of the time by Pieter Brueghel the Elder and other Flemish artists, villagers can be seen quaffing great jugs of lambic, then known as yellow beer. Even today a lambic brewed locally in small quantities is apt to be served at a festival in a Belgian village.

Nowadays larger Belgian brewers, too, produce and even export lambic, capitalizing on popular tastes in some places for hearty, unusual beers and traditional foods. Although lambic beers are still most common in Belgium and parts of the Netherlands and France, they are becoming easier to find elsewhere in Europe and in parts of North America. Given the time-consuming, idiosyncratic nature of lambic brewing, however, the supply is comparatively limited. The output of all lambic breweries adds up to about 370,000 hectoliters a year. In comparison, Boston Beer Company, the 10th largest U.S. brewer and the producer of the Samuel Adams line, brews about 1.1 million hectoliters a year.

Scientific, as well as gustatory, attention has been devoted to lambic lately. Yeast, it turns out, profoundly affects the character of the brew it goes into, and lambic's wild yeasts initiate a fermentation that is complicated, quirky and unfocused. Indeed, lambic arises from a series of stages in which bacterial activity—anathema to other brewing processes—follows yeast fermentation in a sprawling chain of events that produces the relatively large amounts of various sugars and the numerous fragrant compounds, called esters, that give lambic its complex, fruity tastes. Research that began in the mid-1970s at the University of Leuven has finally elucidated much of the chemistry of this centuries-old fermentation.

A Beer Is Born

So little is known about the origins of lambic that there are three different versions of how the word itself came to be. It might have come from any one of four Belgian villages: Lembeek, Borcht-Lombeek, Onze-Lieve-Vrouw-Lombeek or Sint-Katelijne-Lombeek. Another possibility is the Spanish word *lambicado,* which means "carefully prepared." The creation of lambic has also been attributed to Duke Jean IV of Brabant, who in 1428 supposedly tired of the same old brew and hit on the idea of macerating and boiling barley and hops in a still, then known as an *alambic.* The experiment was a success, and the resulting beer has ever since been known as lambic, according to this version.

Old, unblended lambic, close to what was consumed centuries ago, is now easily found only around Brussels and in the Payottenland. Tart and barely carbonated, it tastes more like fine sherry than beer. Much more common are gueuze (pronounced "gerz"), faro and the various lambics sweetened and flavored with fruit.

Gueuze, like champagne, is the product of a secondary fermentation process. It takes place when young and old lambic are mixed in a bottle. Gueuze was apparently first produced commercially early in the 19th century, to make a more bubbly, beerlike beverage suitable for export. Documents have been found attesting to the export, in 1844, of gueuze to Constantinople and to Rio de Janeiro.

Faro is a blend of lambic and mars, a weakly alcoholic and pale liquid obtained by rinsing the grist of a lambic brew. It is generally sweetened with brown crystallized cane sugar. The name comes from the soldiers of the 16th-century emperor Charles V, who called the product "gold liquor" or "barley liquor"—*farro* in Spanish. Fruit lambics include the traditional cherry (known as *kriek,* the Flemish word for "cherry") and raspberry (or *framboise,* from the French). Other fruits have also been used, with varying degrees of success. They include peaches, grapes, black currants, plums and pineapples.

Essentially all beers—with the possible exception of lambic—are either ales or lagers. All share certain basic kinds of raw materials, such as malt and hops. Malt is barley grain that has been steeped in water, has germinated and has then been dried in a kiln. Malting produces in the grain the enzymes necessary to transform starch into sugar during brewing. The process can be varied to produce certain desired characteristics; lambic malt, for example, is pale and very rich in enzymes. Hops, which are derived from a spicelike plant, are available in dozens of varieties and several different forms. The most popular form for lambic brewing are the dried petals of the hop flowers, also known as cones.

In the Beginning, the Wort

All beer starts off in the same way. Malted grain is boiled—that is, brewed—in a cooker with hops and perhaps with some unmalted grains as well. The malt, grain and water mixture is called a wort. It is boiled with the hops for an hour or more, laying the foundation for the two basic taste elements of the finished beer: fruitiness and sweetness, from the malt and grain, and dryness and bitterness, from the hops.

After brewing comes fermentation, in which colonies of yeast, a single-cell living organism, break down sugars from the malt and grain into ethanol, carbon dioxide and other by-products. Fermentation occurs in the absence of oxygen. Yeast exists in many different strains, each of which gives a characteristic flavor. Indeed, one of the many distinctions between ale and lager is the type of yeast used to inoculate the wort; depending on which kind is used, the yeast settles near the top or the bottom of the vessel after fermentation. Brewers jealously guard their yeast strains because of the strains' important role in establishing the beer's flavor.

Such factors apply to all beers, but it is the specifics—the kinds and proportions of water, malt, grains, hops and yeast, the duration of brewing and fermenting, the maturation and, perhaps, blending—that give beer its diversity. Lambic brewers, in particular, are a possessive, secretive lot, guarding recipes that have been refined over decades, if not centuries.

A few important distinctions separate lambic from other beers. For example, lambic is always brewed with a relatively high proportion of unmalted wheat, usually around 35 percent. (German beers, in contrast, never use unmalted grain.) This grain is relatively high in protein and starch, which are not usu-

How Lambic Beer Is Made

BERT VAN DEN BROUKE

Brewing begins when a mixture of barley malt and wheat is mashed with warm water in a mash tun (*above*). The round metal plates stir the infusion, helping to extract the flavor and enzymes of the grains. The brewer adds hot water to this mixture, called a wort, then decants the liquid into a cooker. This liquid is warmed in the cooker to activate the enzymes.

After the mashing and warming, the grain-infused liquid is filtered. Valves (*below*) control the rate of flow through the filters, enabling the brewer to maintain the desired clarity.

ally desirable in brewing. High-protein content leaves lambics slightly hazy; on the bright side, it also prolongs a foamy head.

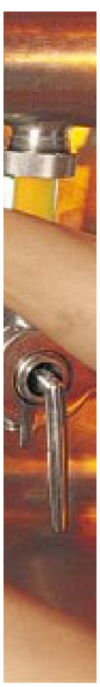
The problem with the wheat starches is that early in the fermentation they lead to high levels of dextrin, a kind of carbohydrate that cannot be broken down by the yeast. Bacterial activity during lambic fermentation does eventually reduce and eliminate dextrins. In moderate amounts, they lend a certain smoothness to a lambic that has fermented for less than a year; by three years, all of them are gone. Unmalted wheat is also relatively low in the enzymes needed for successful brewing—which is why lambic brewers rely on the highly enzymatic, pale barley malt.

Lambic brewing is equally distinctive in its use of hops. In this old brewing style, hops not only flavor but also preserve: their resins contain compounds that inhibit the proliferation of the bacteria responsible for spoilage. Preservation demands relatively great quantities of hops. Ordinarily, such amounts would make the beer too bitter, so lambic brewers use only aged hops at least three years old.

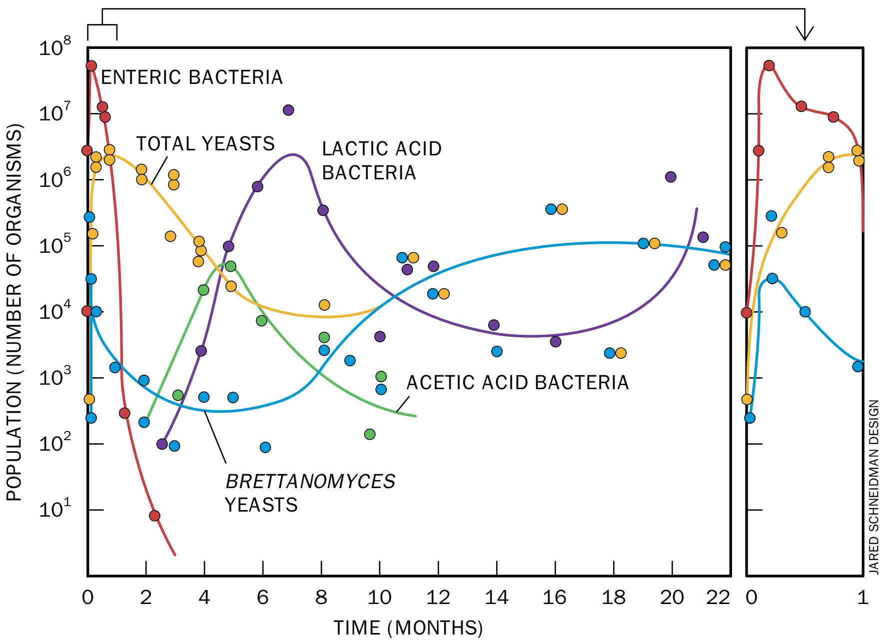
Aging causes the alpha acids, the main source of bitterness, to oxidize and become less bitter. Aging also provokes the oxidation of the hop resins and develops unpleasant haylike and cheesy aromas, but long boiling of the wort eliminates these odors. The traditional favorite is a variety called Coigneau, cultivated in the Asse-Alost area in Belgium. Belgian hops are scarce, however, so hops from the Kent region of England are often substituted.

The traditional brewing method, called turbid mashing, has hardly changed since it was described in a book by the brewer G. Lacambre in 1851. In a vessel called a mash tun, the brewer mashes a mixture of about 40 percent wheat and 60 percent barley malt with water at 40 to 45 degrees Celsius. Added boiling water then brings the temperature up to 62 degrees C, after which the liquid is decanted into a cooker. The brewer then pours more boiling water into the mash tun to reach a temperature of 72 degrees C and mashes the grist a second time. After decantation, the liquid phase is also poured into the cooker. The contents of the cooker—liquid produced by the two successive mashings—are then boiled for 20 minutes and poured again into the mash tun for filtration.

The wort resulting from this filtration goes on eventually to become lambic. The grist left in the mash tun is rinsed with hot water, to produce a second



After filtration, the liquid is boiled in the cooker for four or five hours, during which time the brewer adds hops (*top left*). For lambic, brewers prefer the dried petals of hop flowers (*bottom left*), often from England. They use large quantities of hops because the plant preserves as well as flavors the finished lambic. Mellowed, aged hops prevent the beer from becoming too bitter. During the boiling, samples are taken (*below*) to measure the concentration of sugars.



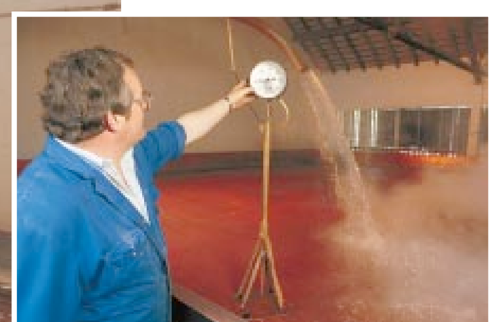
JARED SCHNEIDMAN DESIGN

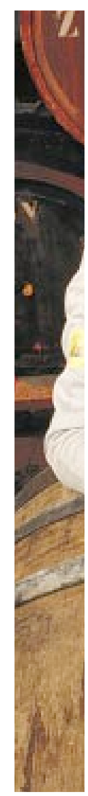
LAMBIC FERMENTATION encompasses the rise and fall of many different populations of yeast and bacteria in four basic stages. In the first, enteric bacteria and wild yeasts predominate and break down glucose into ethanol, carbon dioxide and acids. Then various yeasts create additional ethanol. In stage three, lactic and acetic bacteria make more of these acids. Finally, *Brettanomyces*, a yeast genus, creates the many esters that make the beer uniquely aromatic.

wort to make mars. The other (lambic) wort goes back into the cooker, flowerlike hops are added, and the mixture is boiled for four or five hours. A similar procedure produces mars. After the worts have boiled sufficiently, the brewer filters them to remove the hops.

At this point, the brewing process is complete, and fermentation—the seething riot of chemical and bacterial reactions that actually creates the lambic—begins. It starts with lambic's signature event, unique in all of beer making: the pumping of the hot wort into an open, shallow cooling vessel (also called a tun) in the attic of the brewery. The brewer throws open vented windows, turns on fans and leaves the liquid overnight to cool and be inoculated by the yeasts and other microbial flora of the surrounding air. This exposure to the air is called pitching.

The local conditions are of fundamental importance in pitching. Not only does spontaneous fermentation of wort take place consistently only in a small area around Brussels, but it does so only from October until about April, when outside temperatures remain under 15 degrees C. Some seemingly minute conditions that could affect the balance of microbial flora and the growth rate of the microorganisms would also affect the fermentation sequence and, therefore, the final product. Just how minute some of these conditions may be is a matter of conjecture. Stories are told of one lambic brewer who was faced with a rickety roof that, he was convinced, harbored some critical colonies of microorganisms. So





BERT VAN DEN BROUKE

When the long boil is done, the liquid is pumped into a cooling tun in the brewery's attic (*left*). This is the unique, signature event in the creation of lambic, when local microflora, including wild yeasts, inoculate the brew. Fans circulate the air while the liquid's temperature drops to about 15 degrees Celsius (*above*).

rather than replacing the old roof, he had a new one built over the top of the old one.

After the inoculated wort has cooled, workers pour it into wooden casks for fermentation and maturation. They always use casks of oak or chestnut that had previously held wine, because the wood of new casks would impart an inappropriate tannic taste. Before filling the casks with the wort, the workers scrape and clean the vessels and burn a sulfur wick inside each one to eliminate undesirable molds, which would impart a rotten taste. Even after such cleaning and fumigating, living yeast cells and spores remain within the wood fibers and help to start the fermentation.

Fermentation, which is fairly complex even with the specially cultured yeasts used to make ales and lagers, is much more so with the wild yeasts and bacteria that give rise to lambic. The bacterial activity presents no danger to human health, because the low pH and the presence of hop resins and alcohol combine to eliminate any harmful microorganisms. This, by the way, helps to explain why beer saved countless people from the epidemics of the Middle Ages.

Hubert Verachtert and his colleagues at the University of Leuven have been studying the organic chemistry of lambic fermentation since the 1970s. At last count they had identified 100 different kinds of yeast colonies, 27 colonies of acetic bacteria and 38 colonies of lactic bacteria in a single type of lambic. The difference between the two kinds of bacteria depends on the kind of acid they produce: one creates acetic acid under aerobic conditions; the other makes lactic acid anaerobically.

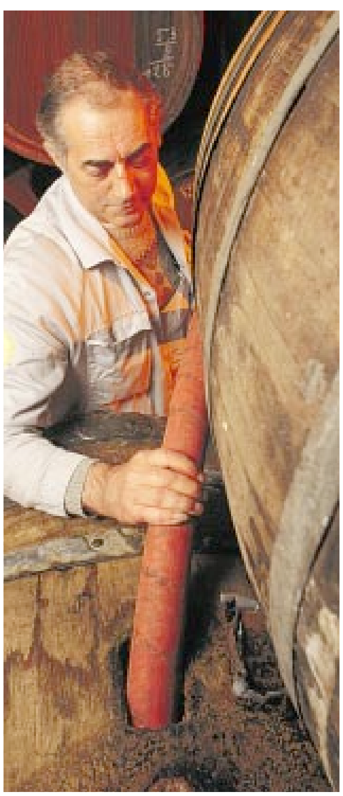
Yeast Feast

Basically, lambic fermentation takes place in four overlapping stages. In the first, wild yeasts (*Kloeckera apiculata*) and enteric bacteria are the dominant agents. The latter produce a sweet, fruity or vegetablelike aroma. *Kloeckera* yeasts have little influence on taste but foster the breaking down, by enzymes, of proteins, which improves the clarity of the beer at low temperatures. In the second stage, *Saccharomyces* yeasts produce all the ethanol that will be present in the finished product and also create aromatic esters that give the beer flavors similar to those of ale. In stage three, lactic bacteria do what they do best: they make lactic acid, imparting to the beer its characteristic sourness. Finally, *Brettanomyces* yeasts give rise to numerous additional esters, bestowing on lambic its signature fruity, winey taste and aroma.

The first stage starts after three to seven days with the proliferation of the enteric bacteria and wild yeasts. Enteric bacteria multiply very quickly and give rise to a so-called mixed-acid fermentation, which means that they break down glucose not only into ethanol and carbon dioxide but also into lactic acid and acetic acid. But because they cannot survive in acetic acid or ethanol, the enteric bacteria population diminishes and then disappears after 30 or 40 days. The *K. apiculata* grows by breaking down glucose but not more complex sugars, so it disappears quite rapidly when the glucose is gone. Before it does, however, its presence produces a small amount of ethanol and generates almost all the acetic acid to be found in the final product.

After 10 or 15 days, the main, alcohol-producing fermentation begins. At this point, the population of wild yeasts is being eclipsed by the proliferation of a different yeast genus, *Saccharomyces*. This genus, incidentally, is the same one used to inoculate ales, in which case they are *S. cerevisiae,* and lagers, in which case they are *S. carlsbergensis*. (Ales and lagers ferment for only a week.)

In lambic, *Saccharomyces* yeasts assimilate and ferment most of the wort's sugars, breaking them down into alcohol and carbon dioxide. The fermentation manifests itself for a couple of days



After the brew has cooled, usually overnight, it is poured into wooden casks (*left*) that were used previously to ferment wine. (The wood of new casks would impart an unpleasant taste.) Even after they are cleaned and fumigated, the casks contain yeast spores that help to start the fermentation. After about a week, the fermentation is so energetic that foam sputters out of escape valves in the casks (*below*).

The beer matures for one or more years. Then, based on taste testing alone, the brew may be blended with younger or older lambics.

as foam sputters and overflows out of the cask's carbon dioxide escape hole. This stage goes on for about seven months. Vigorous though the fermentation is, it is not what brings about the characteristic flavors of lambic, although even at six months some lambics are ready for use in blending the final product.

Stage three, which overlaps stage two, begins after three or four months. This period is characterized by the proliferation of both lactic and acetic bacteria, which reaches a peak after six to eight months. In fact, another reason why lambic brewing always starts between October and April is so that this peak is later assured by summer temperatures above 20 or 25 degrees C.

The lactic acid bacteria created during this phase are responsible for the sour-vinous character of lambic. They are mostly of the *Pediococcus* genus, which converts sugars to lactic acid. Annoyingly, some strains of *Pediococcus* tend to form slime. Fortunately, it eventually disappears, although a slight haze persists. The haze, called double face, cannot be eliminated by filtration.

Acetic bacteria also have undesirable effects, tending to make the beer acidic ("hard") by production of acetic acid from ethanol. Such problems become serious only in damaged or leaky casks that have allowed in air, which nurtures the aerobic *Acetomonas* bacteria.

After eight months, a new increase of yeast cells signifies the beginning of the fourth, and final, stage of lambic's complex fermentation. These yeast strains, first identified in lambic beer, belong mainly to *Brettanomyces*. They play a critical role in establishing the beer's aromatic profile and, therefore, its flavor. The aromatic profile is determined mainly by the concentrations of the beer's many esters, which are, in turn, fostered by *Brettanomyces*. These yeasts produce an enzyme that promotes the reactions that transform acids and alcohol into esters (and vice versa, a phenomenon known as hydrolysis). The most influential of these esters are ethyl lactate and ethyl acetate, by-products of the lactic and acetic acid of the previous stage.

Another characteristic of *Brettanomyces* yeasts is that, in the presence of air, they form a film on the surface of the beer. Other yeasts, too, participate. Without this film, the beer would oxidize, and the acetic bacteria would run rampant, making vinegar instead of beer. Despite the best efforts of brewers, this can happen from time to time.

Another Fermentation

Even after this complex, yearlong fermentation, the beer is, generally, not yet ready for drinking. As mentioned earlier, the most common unflavored lambic, gueuze, is a blend of young and old lambics, going from smooth (mostly young) to tart and complex (mostly old). The exact blending is decided on the basis of taste testing alone. An additional fermentation occurs when the sugars present in a young lambic, about a year old, encounter the more developed suite of yeasts in an older lambic of, say, two or three years. In the traditional method, the blend is refermented in the bottle.

If older lambic predominates in this refermentation, the *Brettanomyces* thoroughly assimilates the complex sugars, leaving an overattenuated, very dry product. It also becomes very aromatic because of the esterification activity of *Brettanomyces*. These qualities would be less intense in a younger average blend, which would be "softer" and smoother. The taste teams have to be aware of the necessary standards and obtain a completely consistent final product by blending very heterogeneous lambics. Regardless of the final blend, the beer differs from ordinary ales and lagers mainly because it has organic acids and a complex suite of esters.

Currently most products are softer ones, which are filtered and pasteurized. The old blends, refermented in the bottle, need careful handling and storage in a cool, dark cellar for at least a year.

Fruit lambics, too, undergo a secondary fermentation, triggered by the sugar in the fruit. Cherry lambic is perhaps the most traditional. Sour Schaarbeek cherries were used in the past, but they have just about disappeared from the market. So brewers generally use Gorsem cherries, which are larger, juicier and convey a sweeter taste. At cherry-picking time, in July, workers prepare all the casks needed for a complete production year. They put about 80 kilos of fruit, complete with stones, into every 650-liter cask and pour in young lambic of that season. Fermentation then starts again, and the beer is left to ferment for one to two years.

Can Lambic Survive?

Lambic is a living anachronism. The very characteristics that make the beer unique are also liabilities, from a business standpoint. Before the work of Louis Pasteur, lambic was the only beer that could be preserved for months or even years. In a relatively low cost operation, lambic brewers could produce large volumes in the winter and then sell the product all year. Although preservation is no longer a problem, maturing great quantities of the beverage for months or years means that at any given time, much of the lambic brewer's capital is immobilized.

In addition, many modern food laws and regulations require minute control over the entire preparation process. By its very nature, however, spontaneous fermentation is not controllable to any real extent.

Lambic's future rests with adventurous beer lovers and that small but enthusiastic segment of the population that goes out of its way to sample traditional ethnic foods. Lately this group seems to be expanding as more people pass up processed foods in favor of the old staples: fine cheeses, hearty breads, wines, abbey beers and real ales. Who knows? If the trend continues, lambic may be around for another 500 years. SA

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Further Reading

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