

Sumerian Beer: The Origins of Brewing Technology in Ancient Mesopotamia*

Peter Damerow

Max Planck Institute for the History of Science, Berlin

§1. Introduction

§1.1. The role of beer in the cultural context of ancient Mesopotamia

The following paper is concerned with the technology of brewing beer in the Sumerian culture of ancient Mesopotamia, which we know about from cuneiform texts of the 3rd millennium BC. and from reminiscences in later scribal traditions which preserved the Sumerian language and literature. Beer is an alcoholic beverage produced from cereals by enzymatic conversion of starch into fermentable sugar followed by a fermenting process. The term “Sumerian beer” will be used here in order to denote the specific technology of the earliest type of such beer about which there is extensive written documentation available. The use of this term, however, neither implies that the Sumerians invented this technology, nor excludes that the same or a similar technology was also used by other people in the wider area of Mesopotamia and its neighborhoods. The term is used here simply to indicate the main type of sources the present paper is based on.

§1.2. The technique of brewing beer was, in fact, an early technological achievement which presumably predates considerably the advent of the Sumerians in the lowlands of the Mesopotamian alluvial plane. Its invention has even been discussed as a possible motive for a much earlier, decisive step in the development of human culture, the so-called “Neolithic Revolution.” It has been argued,¹ that it was the discovery of the in-

toxicating effect of the alcohol contained in beer rather than the use of grain for other foodstuffs that caused the transition from hunting and gathering to living in stable settlements, domesticating animals, and cultivating the soil. This transition emerged around 7000 BC. in the border territory of the alluvial plane of Mesopotamia.² There is, however, no conclusive archaeological evidence for the invention of beer brewing technology as early as the beginning of the Neolithic period. Nevertheless, there can be no doubt that the emergence of agriculture was closely related to the processing of grain after the harvest, and that beer brewing soon belonged to the basic technologies of grain conservation and consumption.

§1.3. At the beginning of the 4th millennium BC, climate changes caused a dramatic decrease in the water level, followed by the emergence of settlements in the centre and southern parts of the extremely fertile plane, that is, the area which in the 3rd millennium BC became the centre of the Sumerian culture. This development brought about the emergence of large cities, the stratification of the society into social classes with different access to resources, and the invention of tools such as seals, clay tokens, numerical tablets, and proto-cuneiform writing. These tools were originally required only for controlling the growing redistributive economy. In the first half of the 3rd millennium BC, however, proto-cuneiform writing developed rapidly into a full-fledged writing system, used first for the Sumerian, but soon applied also to the Akkadian language.

§1.3. Even the earliest texts of this tradition provide

critical discussion see Joffe et al. 1998.

² For the early history of Mesopotamia see Nissen 1988.

* References to cuneiform texts use abbreviations of text editions from the standard abbreviations list of the CDLI; “W” is used in field numbers of tablets excavated at Uruk/Warka.

¹ Braidwood et. al. 1953; Katz and Maytag 1991. For a

information about beer. Proto-cuneiform texts dating from 3200 to 3000 BC document that at the time when writing was invented beer was no longer simply an agricultural product of the rural settlements, but rather belonged to the products subjected to the centralized economy of Sumerian states. Beer was one of the surplus products of the new economy of early cities in which it was characteristic that production and consumption were virtually independent of each other, both being controlled by a sometimes hypertrophic bureaucracy. The continuous documentation of the production and consumption of beer by administrative cuneiform documents in the following millennia indicates that Sumerian beer retained this role even after the decline of the Sumerian culture.³

§2. Overview of the sources

§2.1. Information about Sumerian beer is provided by three types of sources:

- *by administrative documents,*
- *by literary texts dealing with myths or with legislation, and*
- *by archaeological remnants of beer production and consumption.*

Administrative documents represent by far the richest source.⁴ Hundreds of such texts document more or less explicitly administrative activities performed in the context of the production, distribution, and consumption of beer, although the information they provide is specifically restricted. They were written for people who knew the context of beer production and distribution and not to inform modern readers about these processes. They contain detailed records of the required raw materials, of the amounts of beer produced, and of economic transactions such as the delivery of raw materials and the disbursement of beer products but not, however, about the real activities performed in brewing processes. Information about brewing technology

can, at best, be inferred indirectly from the terminology used. The products resulting from processes of preparing the raw materials and performing the brewing process are designated by certain technical terms indicating their nature. But the meaning of these technical terms is determined by the very brewing activities unknown to us and can thus be reconstructed only on the basis of hypotheses about the nature of these brewing activities. Moreover, the methods of bookkeeping about such activities varied with locations and time periods. We will see below that, as a consequence of this diversification, clear relationships between the technical terminologies of different text groups are widely missing. The information about the technology of brewing Sumerian beer they provide is thus often incoherent.

§2.2. This difficulty of interpreting the numerous administrative documents concerning beer brewing has impelled scholars to reconstruct the meaning of the ancient terms by applying modern knowledge about fermentation chemistry and brewing technology. Thus, most of the translations and interpretations of these terms assume that the process of beer brewing and the raw materials and products involved are known to us so that the only problem lies in attributing the correct modern terms to the ancient ones. But while this assumption is necessarily true for the basic chemical reactions involved—the decomposition of starch by means of enzymes produced in the process of malting grains and by later fermenting the resulting product by means of yeast bacteria—the variety of possible techniques to realize these reactions is too great to allow any reliable identification of the specific ancient procedures used and products attained. Moreover, these chemical reactions have been realized in the brewing process by practitioners to whom they were essentially unknown. Their understanding of the brewing process and consequently the meaning of the terms they used necessarily differed from modern brewing terminology. Translations of the terms ignoring this difference attribute anachronistically modern knowledge to the ancient brewers and ascribe to the ancient terminology questionable meanings. In fact, even crucial questions, such as which raw materials used in the brewing process were malted before they were processed, remain controversial.⁵

§2.3. The second source of information about Sumerian beer is provided by various types of literary texts, though the extant copies were written down only after

³ Beer was a major topic of the early pioneering work in Hrozný 1913. For a comprehensive later survey of beer in Mesopotamia see Röllig 1970, with additions by the review of Stol 1971.

⁴ The ancient archives are now scattered all over the world in public and private collections, partly published in hundreds of isolated books and articles. In cooperation with these collections, the Cuneiform Digital Library Initiative (CDLI <<http://cdli.ucla.edu>>) is currently reconstructing the administrative archives of the third millennium B.C. in a comprehensive electronic database, freely accessible in the internet. The present article is primarily based on electronic data of this project.

⁵ See Stol 1990.

the decline of Sumerian culture.⁶ The most important of these texts is the so-called Hymn to Ninkasi. This poetical work is a kind of mythical poem or song dedicated to Ninkasi, the goddess of brewing, a minor goddess in the Sumerian pantheon. The hymn is known from three copies which were written in the Old Babylonian period about 1800 BC. In all three copies the hymn is accompanied by another poem, a kind of drinking song, probably dedicated to a female tavern-keeper at the opening ceremony of her tavern. The hymn itself contains, in mythological glorification, a description of the brewing process. This description is the most important source on which our current knowledge of this process is based. But, as in the case of administrative documents, it is again difficult to unambiguously read, understand, and translate this description due to our limited knowledge of the context of beer brewing in the Sumerian culture and, in particular, of the terminology relating to it.

§2.4. Some information about the brewing process is also provided by allusions to beer and beer brewing in other literary compositions such as heroic poems and collections of proverbs, or, much later, medical texts and lexical lists. Although such allusions are mostly incomprehensible in themselves, they help to improve the interpretation of the description of the brewing process in the Hymn to Ninkasi.

§2.5. A further genre of literary documents providing some knowledge about beer in ancient Mesopotamia is represented by such royal promulgations as the so-called Code of Hammurapi. This code is a record of punishments imposed for committing certain crimes. Among these crimes are listed, in particular, violations of regulations concerning the distribution of beer in taverns and of regulations concerning payment for its consumption.

§2.6. Finally, some information about beer brewing is provided by certain sections of a very specific type of Sumerian literature, the so-called “lexical lists.” Such lists are ancient compilations of Sumerian technical terms together with translations into Akkadian. They were repeatedly copied by the disciples of scribal schools in order to learn Sumerian.⁷

⁶ The Sumerian literary texts are being made available through the internet by the project: The Electronic Text Corpus of Sumerian Literature, see <http://www-etcsl.orient.ox.ac.uk>.

⁷ For the terminology of brewing in such lists see Hartman



Fig. 1: Impression of a Sumerian cylinder seal from the Early Dynastic IIIa period (ca. 2600 BC; see Woolley 1934, pl. 200, no. 102 [BM 121545]). Persons drinking beer are depicted in the upper row. The habit of drinking beer together from a large vessel using long stalks went out of fashion after the decline of Sumerian culture in the 2nd millennium BC.

§2.7. The third source of information about Sumerian beer is represented by archaeological remnants of the production and consumption of the beer itself. However, in spite of a long tradition of Near Eastern archaeology, scholarly investigations dealing with Sumerian beer made little use of these sources. Such studies have been based predominantly on textual evidence provided by the administrative and literary documents described above. This implausible restriction seems to be an effect of boundaries between disciplines. On the one hand, treatments of the topic by philologists only make eclectic use of archaeological sources other than cuneiform texts. They rarely take into account sources such as the tools and containers used for beer production and distribution, which correspond to their depictions on reliefs and seals. Archaeologists, on the other hand, classify their findings of containers for various goods mainly according to stylistic and chronological criteria. They rarely use textual evidence to determine the original usage of their findings, as is documented by administrative texts.

§2.8. There are, however, some exceptions. In 1992, an investigation concerning archaeological remains of beer brewing was published.⁸ By chemical analysis a pale yellowish residuum in crisscross grooves on the inside shoulder of a late fourth millennium vessel found at Godin Tepe has been identified as consisting of an oxalate. The comparison with remains in an Egyptian beer jug and with remains called “beer-stone” in containers of

and Oppenheim 1950.

⁸ See Michel, McGovern, and Badler 1992.

modern fermentation processes suggests that the vessel was used for the processing or storage of ancient beer. Given the ample textual evidence of beer in roughly contemporary proto-cuneiform texts, this finding is not sensational. However, the investigation at least indicates the potential profit to be gained from an identification of archaeological findings with objects and activities known from ancient administrative documents.

§2.9. In 2006, an even more remarkable paper was published presenting the results of an interdisciplinary study of archaeological finds at Tall Bazi (Zarnkow et al. 2006). These finds indicated the brewing of beer in a considerable number of households. The research group that published the paper consisted of specialists of brewing technology from the Technical University of Munich, and archeologists from the Institute for Near Eastern Archeology of the University of Munich. They investigated the equipment found, *in situ*, of an exceptionally well preserved occupation level of the 13th century BC stratum of Tall Bazi. It turned out that many of the excavated houses were equipped with a large, barrel-shaped vessel half buried in the floor, with a capacity of up to 200 liters. Based on the identification of oxalate in residues on the inner ceramic surface, and partly even of the yeast bacteria required for fermentation, these large vessels were exclusively used to produce and store beer. Burying them partly in the ground will have resulted in a weak vertical temperature gradient and thus a circulation of the contents between the upper and the lower halves. These barrels were often accompanied by another type of vessel with holes in their bottom and a capacity of about 100 liters. Based on the identification of oxalate and tartrate on the surface of these vessels, they must have been used somehow to handle beer, but also wine. Furthermore, some smaller vessels, jars and cups could be identified as having also been used to store or consume beer. These vessels were unearthed together with devices used in grain milling, suggesting that beer was regularly produced within the individual households of the Tall Bazi settlement.

§2.10. This brief critical overview of the three types of sources, i.e. administrative documents, literary texts, and archaeological remnants of beer production and consumption, may indicate that in spite of an abundance of available sources, any reconstruction of the Sumerian beer brewing technology faces great difficulties. It is impossible to provide a full treatment of these difficulties within the framework of the present paper. The following sketchy discussion of some details of the Sumerian beer brewing tradition rather aims at offering

a realistic impression of what kind of knowledge we can gain from these sources and what kind of questions remain necessarily unanswered for the time being.

§3. Beer types and ingredients in proto-cuneiform documents

§3.1. It has already been pointed out that beer was produced in ancient Mesopotamia long before the invention of writing. Beer is, at least, one of the economic goods whose distribution or delivery was recorded on the earliest administrative documents that survived; that is the proto-cuneiform administrative documents written in the Late Uruk period between 3200 and 3000 BC. Beer was one of several grain products controlled by the officials of central households conventionally associated with temples and palaces.

§3.2. What do we know from these records about the nature of this beer and about its ingredients at that time? Nine different types of beer have been identified so far.⁹ Their representation was based on signs depicting various types of beer jugs (signs DUG_a, KAŠ_a, ŠEN_b, ŠEN_c, ZATU710). Sometimes not only a certain number of beer jugs but also the amounts of some ingredients necessary for their production were registered, so that some information about these ingredients can be inferred. We know, in particular, that some of these beer types were distinguished further by the amounts of ingredients contained in each jug of beer or by the sizes of these jugs. In one case this differentiation has even been made explicit by qualifying signs (sign combinations ŠEN_b GAL and ŠEN_b TUR, i.e. ŠEN_b-beer qualified as “big” or “small,” respectively).

§3.3. In contrast to later habits, however, all records concerning beer in proto-cuneiform administrative documents only provide information about the same two basic ingredients. They do not provide any information about further ingredients which might have been responsible for the differentiation of the beer types represented by different signs. The raw material for the two ingredients actually registered in the documents was probably the same. It must have been barley (sign ŠE representing an ear of a cereal plant) processed in two different ways to obtain these two ingredients. The first of these ingredients is also known as a common ingredient of other cereal products. According to its usage it may have been some kind of coarsely-ground barley. The second ingredient, designated by the use of

⁹ See Englund 2001; Nissen, Damerow, and Englund 1993.

a specific numerical notation system, occurs in proto-cuneiform texts either as an independent product or as an ingredient of beer, but never as an ingredient of other cereal products. In all likelihood, this ingredient was malt gained from barley by a controlled germination process.

§3.4. The production and distribution of various types of beer was an integral part of a system of processing grain into various intermediate and final grain products. One of these products deserves special attention although it had apparently nothing to do with beer brewing technology at that time—in contrast to its close connection to beer brewing in later periods. This grain product, usually called “ninda” and considered as “bread,” was represented by the sign GAR depicting a ration bowl characteristic of the Late Uruk period. An abundance of such bowls with a size of approximately 0.8 liters has been excavated from archaeological layers dating back to the time when proto-cuneiform writing was invented.

§3.5. In the proto-cuneiform administrative documents the sign GAR depicting this ration bowl was used with two different meanings. On the one hand, the sign GAR designated, in fact, daily rations of barley prepared for workers from a certain amount of grain. The grain was probably, in order to make it digestible, processed by grinding and possibly roasting or baking it in the bowl. Whereas numbers of beer jugs were recorded using the well-known sexagesimal counting system of the Sumerians, these rations were counted using a specific “bisexagesimal” system of numeration for rations which mostly disappeared when in the Early Dynastic period proto-cuneiform developed into cuneiform writing.¹⁰

§3.6. On the other hand, the sign GAR was used in a generalized way. It designated totals of various grain products. These totals were calculated by adding up entries containing the numbers of units of different products containing barley.¹¹ It is remarkable that such entries were totalled in spite of the fact that they represented considerably different amounts of barley required for their production. Among these products were even rations designated also by the sign GAR us-

ing its more specific meaning to designate such rations. Other products included were directly designated by numerical signs which indicated how many units of the product could be produced from a certain capacity unit of barley, a way of qualifying barley products which can also be found in documents of later periods. The sign GAR was used, thus, in order to denote all cereal products counted bisexagesimally, that is, virtually all barley product rations except beer.

§3.7. This original usage of the sign GAR in proto-cuneiform documents is remarkable because, in contrast to its later use, it denoted barley products which apparently played no role in the process of brewing beer whereas, as we will see below, it was used later in such close connection to beer brewing that it is commonly assumed that Sumerian beer was brewed essentially from “bread.”

§3.8. Another sign, however, which later played a role in the terminology related to beer brewing, the sign ŠIM, in fact already had a close connection to this technology in proto-cuneiform documents, although again must have changed its meaning. The sign probably depicts a vessel with a spout at the bottom as was later used in the brewing process, the spout serving to separate the beer from the yeast floating on top after the fermentation process. In proto-cuneiform documents the sign occurs as part of names or titles of persons or institutions, probably indicating their role in the beer brewing process.¹²

§4. Beer types and ingredients in the Old Sumerian period

§4.1. Some 600 years later, in the pre-Sargonic Lagash period around the middle of the 3rd millennium BC, the administrative records on beer show a different format.¹³ Again the entries concern a number of different types of beer which by then, however, were characterized by reasonable designations such as “golden(?) beer” (kaš₂ sig₁₅, written kaš₂ KAL), “dark beer” (kaš₂ ge₆), “sweet dark beer” (kaš₂ ge₆ du₁₀-ga), “red beer” (kaš₂ sa₄), and “strained beer” (kaš₂ sur-ra). Unfortunately,

¹⁰ For the numerical sign systems in proto-cuneiform documents and their areas of application see Damerow and Englund 1987 or the brief report in Nissen, Damerow, & Englund 1993.

¹¹ See e.g. such totals on the tablets *MSVO* 1, 84, 93, 10 and 111.

¹² See, for instance, the examples of the name/title “KU-ŠIM” in chapter 8 of Nissen, Damerow, and Englund 1993 and the name/title “EN_a-ŠIM” in the subscript of a list of barley products of the text *ATU* 5, pl. 2, W 5233,b depicted on page 34 (fig. 32) of the same publication.

¹³ See the extensive discussion of Old Sumerian beer accounts in Powell 1994.

these Old Sumerian designations cannot be correlated with the ideograms representing different beer types in the earlier proto-cuneiform documents. Some of the beer types seem to differ in any case from those referred to in the earlier texts since they contain ingredients prepared from emmer, a kind of wheat which is no longer commonly cultivated today (ziz₂, sign AŠ₂, derived from the sign of the unit of the proto-cuneiform numerical notation system for emmer). Emmer is also well attested in proto-cuneiform documents, though not as an ingredient in beer.

§4.2. Old Sumerian documents specify in any case more ingredients than the two raw materials registered in the proto-cuneiform documents of the Late Uruk period.¹⁴ Some of them may have been intermediate products of the brewing process, kept and stored for later use. A number of tablets from the archives of the city of Girsu, for instance, register grain products used for brewing beer which are denoted by technical terms such as “munu” (sign BULUG₃, read munu_x), “bappir” (sign KAŠ×GAR, read bappir₃), “imgaga” (written AŠ₂-AN, read imgaga₃), “GAR tam-ma” (written GAR UD-MA), and “titab” (written GUG₂-BULUG₃, read titab₂). All of these terms belong to those mentioned above, the meaning of which is far from obvious. What these terms designated can only be inferred indirectly from the basic meaning of the signs used, from the context in which they occur, from the measures used, and from the amounts occurring in the documents.¹⁵

§4.3. Two ingredients seem to have been virtually always involved in Old Sumerian beer production, and it is plausible to assume that they somehow correspond to the two ingredients of beer in proto-cuneiform documents of the Late Uruk period. The first, “munu,” was delivered in sacks, baskets, or vessels. The meaning of this term is unanimously considered to be the designa-

tion of malt obtained from barley by germination, thus being one of the two ingredients known from the earlier proto-cuneiform documents. The fact that the sign used to denote this ingredient (BULUG₃) had not been used for this purpose in the proto-cuneiform documents can easily be explained. The use of a specific numerical notation system for malt made it unnecessary at that early time to use any further sign for its identification.

§4.4. The second ingredient always contained in Old Sumerian beer was “bappir.” The meaning of this term is much more debatable. The term was represented in Old Sumerian documents by a sign combination consisting of two signs well known from proto-cuneiform documents, but only as independent signs. This sign combination consists of the sign GAR, originally representing a barley ration, inscribed now into the sign KAŠ which originally depicted a beer jug representing a common type of beer. This new sign combination, written KAŠ×GAR, read bappir₃,¹⁶ thus seems to suggest that the beer brewing technology had meanwhile changed. It seems that barley processed in the same way as the production of GAR rations was now used as a basic ingredient of beer, substituting the coarsely-ground barley.

§4.5. Other peculiarities in the use of signs warn us, however, not to draw such facile conclusions. It is, for instance, puzzling that in the Old Sumerian documents (as a peculiarity of this period) the sign KAŠ itself was not the sign used to designate beer, but rather one (sign KASKAL, reading kaš₂) which does not depict something that had any obvious connection with brewing technology. It is also puzzling that in texts written earlier than the Old Sumerian administrative documents a similar but different sign combination played a role. In the texts from Ur dating to the Early Dynastic I period (ca. 2900 BC) and the texts from Fara dating to the Early Dynastic IIIa period (ca. 2600 BC), the sign for barley rations (GAR) occurs inscribed into the sign representing a brewing vessel or tool (ŠIM), and this sign combination (ŠIM×GAR) was apparently used in these texts to designate the profession of a brewer (Sumerian *lunga*). It must be this sign combination which led to the combination of signs for the Old Sumerian term

¹⁴ The identification of ingredients is based on deliveries to brewers. See, for instance, the following texts: *AWL* 41-43, 47, and 58-63; *Nik* 1, 57, 59-64, 67, 83, and 142; *AWAS* 29-35. Powell 1994 suggests distinguishing two types of sources, those which only document deliveries to brewers and those which also specify the type and amount of beer to be produced from such ingredients, documents such as *AWL* 60, 62, and *AWAS* 47. His far-reaching conclusions about the ingredients of the various beer types are based on an analysis of the latter group of documents taking the registered amounts of figures as representing realistically the compositions of the beer types.

¹⁵ See, for instance, the texts *AWL* 41, 60, and 62.

¹⁶ This sign combination replaced a proto-cuneiform sign combination identified as “BAPPIR” on the basis of its position in a lexical list (see Englund & Nissen 1993) which, however, was not used in connection with beer and seems to have had no direct bearing on the later tradition.

“bappir” (KAŠ×GAR) in the following Old Sumerian period (specifically at Girsu, modern Tello) by substituting the sign representing a beer jug for the sign representing the brewer’s tool and now using it not or not only for the brewer but instead or also for an essential ingredient of the beer he produced.

§4.6. It has been mentioned already that the sign GAR is commonly interpreted as a term “ninda” designating “bread.” This interpretation of the sign together with certain indications that “bappir” was cooked or baked¹⁷ led scholars to assume that “bappir” was just a special kind of bread, so that the term is commonly translated as “beer bread.” This designation as “beer bread” is, however, at least misleading. The Old Sumerian ingredient “bappir” was never counted as one would expect if it had been, in fact, a kind of bread. It was registered instead using capacity measures just as the coarsely-ground barley in the earlier proto-cuneiform documents which was now substituted by “bappir.”¹⁸

§4.7. The identification of further ingredients in Old Sumerian beer raises even greater difficulties than the determination of its two basic ingredients. Some hints are provided by the designations of the beer types for which they were used. “Golden? beer,” “red beer,” and “strained beer” contain emmer in the form of “imgaga” in addition to malt (i.e., “munu”) and “bappir.” What distinguishes these three types of differently named beers? Common answers to this question are, on the one hand, based on a philologically close reading and literal interpretation of the terminology. On the other hand, they are based on quantitative relations between the amounts of ingredients allocated to the brewers or credited to them when they delivered the beer. Such quantitative relations are interpreted as directly reflecting the quantitative compositions of the beer types the brewers produced.

§4.8. In both cases, the inferences are rather speculative and not altogether convincing. Widely differing interpretations can be justified philologically such as, for example, the interpretation of “kaš₂ sig₁₅” as “golden beer”¹⁹ and as “strong beer.”²⁰ In any case, such historically developing designations are often influenced

by accidental circumstances. Conclusions concerning details of the brewing technology based on the etymology of technical terms cannot be very reliable. The same is true for the interpretation of quantitative relations between beer ingredients in the administrative documents. Given that in the Old Sumerian period the bureaucracy already acted to such an extent normative that, for instance, in some cases the monthly amounts of ingredients delivered to brewers remained constant over a period of more than ten years,²¹ it seems likewise implausible that they could have realistically reflected quantitative relations of the actual brewing processes pursued.

§4.9. More specific information about the ingredients of Old Sumerian beer can be inferred from the context of their usage. In some cases, for instance, deliveries of barley and emmer to brewers are qualified by adding one of the terms for these ingredients (e.g., še bappir) and by complementing the entry with another one designated as its “bala” (literally “crossing”) which contains a specific fraction of the amount of grain specified in the first entry. Such qualifications are commonly interpreted as indicating what product the registered amount of grain is to be used for (e.g. še bappir = “še for bappir”) and how much has to be added to this amount in order to compensate for the loss expected by processing the grain (e.g. še bala-bi = “it’s barley conversion,” i.e., the amount of “še” to be added in order to compensate for the loss when “bappir” is prepared). The specific fraction added in order to compensate the loss thus provides a hint at the nature of the treatment applied to the grain in order to achieve the indicated product. In the case of the use of barley (še) for the preparation of “bappir,” for example, one third of the amount of barley is added as it’s “bala,” or in the case of emmer (ziz₂) used for the preparation of “imgaga,” one sixth of the

²⁰ See e.g. Bauer 1972 passim. Selz (1989: 246-247) argues against both translations.

²¹ This statement is based on a comparison of corresponding entries in the following texts from the period between the first ruling year of Lugalanda (2358 BC) and the sixth ruling year of UruKagina (2347 BC): *AWL* 41 (Lug 1/10), 42 (Lug 3/1), *AWAS* 29 (Lug 7/1), *AWL* 43 (Ukg 1/2), *AWAS* 31 (Ukg 1/3), 30 (Ukg 1/9), *Nik* 1, 60 (Ukg. 2/9), 64 (Ukg 2/11), 59 (Ukg 3/5), 63 (Ukg. 3/11), *AWAS* 32 (Ukg 4/2), 33 (Ukg 4/8), 34 (Ukg. 5/5), 35 (Ukg 5/6), and *Nik* 1, 57 (Ukg 6/1). In particular the fact that an uneven entry of 10 gur minus 3 barig 2 ban₂ of white emmer was kept constant over years (i.e., from the seventh ruling year of Lugalanda to the fourth year of UruKagina) strongly suggests that these figures were normative rather than empirical.

¹⁷ See Alster and Vanstiphout 1987: 23.

¹⁸ See the critical discussion by Powell 1994: 97, which is, however, still based on the problematic translation “bread” for “GAR.”

¹⁹ See e.g. Powell 1994 (translation discussed on p. 104).

amount of emmer is added. While in the case of barley used for the preparation of “bappir” the interpretation of the amount added varies with the hypothesis regarding what “bappir” designates, it is commonly interpreted in the case of emmer used to prepare “imgaga” as an indication that “imgaga” has to be considered as dehusked emmer: that is emmer removed from its glume.

§4.10. Only two Old Sumerian beer types had such specific ingredients that they can be distinguished from all other types by the delivery of these ingredients to the brewers. These two beers are the dark beer (kaš₂ ge₆) and the sweet dark beer (kaš₂ ge₆ du₁₀-ga). In addition to the two basic ingredients malt and “bappir,” the dark beer contained “titab,” the sweet dark beer emmer and “GAR tam-ma,” which may have sweetened the beer.

§4.11. Again the difficulty in determining what the terms of the ingredients actually denote limits the value of the information provided by administrative documents. The term “titab” definitely designates a barley product. This follows from deliveries of barley to brewers to be used for the production of “titab” (še titab, interpreted as “še for titab”).²² It is also indicated by the original meaning of the signs used for its rendering. The barley product “titab” was written as a combination of two signs (GUG₂-BULUG₃). In the earlier protocuneiform documents the first of these signs (GUG₂) represented a specific amount of barley processed in a certain form to be distributed as a special kind of ration prepared from grain. Based on later usage this sign is commonly translated as “cake.” The second sign (BULUG₃) is, as was mentioned above, the sign which with the reading “munu” designated malt in Old Sumerian documents.

§4.12. Thus, the term “titab” represented by the combination of both signs may have designated a barley product, the preparation of which somehow included a germination process converting barley into malt or, at least, a product containing barley mixed with some prefabricated malt. Furthermore, there are indications in later literary sources that the production of “titab”—just as that of “bappir”—included heating in an oven.²³ Moreover, such sources suggest that “titab” at some stage in the production of beer was spread out on reed mats, probably to cool it down. This, however, is essentially all that is known about “titab.” We do not have any further information about its production and its

²² See *AWL* 41 ii 8.

²³ See Alster and Vanstiphout 1987: 23.

use in brewing beer or for other purposes. Accordingly, the opinions about what “titab” was really like differ considerably. Even the basic question of whether “titab” was a generic term denoting the beer mash at a certain stage of the process of beer production or whether it designated a specific addition to the mash cannot be answered satisfactorily.

§4.13. The situation is even worse in the case of the specific ingredient called “GAR tam-ma” that distinguished “sweet dark beer” (kaš₂ ge₆ du₁₀-ga) from all other types of Old Sumerian beer. Again to conclude from the term “GAR” that this ingredient must be a kind of bread is highly problematic and in conflict with the fact that “GAR tam-ma” just as the “beer bread” “bappir” is not counted but always quantified by capacity measures. The qualification “tam-ma” added to the term “GAR” has no obvious translation. Identifications such as “bread produced from crushed flour”²⁴ or “torrified malt crushed and sieved to leave a rather dark malt extract”²⁵ can hardly be considered more than noteworthy, albeit widely unfounded, speculations.

§4.14. In spite of these difficulties in determining the ingredients of Old Sumerian beer it is obvious that it was quite different from our modern beer. Like any ancient beer it differs from modern beer in that the addition of hops did not yet form part of the brewing technology. There is, however, another peculiarity of Old Sumerian beer. A characteristic feature, not only of beer brewed in the Late Uruk period but of Sumerian beer in general, may have been that the wort which was prepared for fermentation contained—in addition to malt and water—considerable amounts of an ingredient which had not been subjected to a germination process. This ingredient may originally have simply been crushed barley. From the Old Sumerian period onwards “bappir” and possibly even further ingredients with designations somehow related to “GAR” seemed to be ingredients of beer prepared from barley or other grains involving no malting process at all.²⁶

§5. Beer types and ingredients in the neo-Sumerian

²⁴ See Selz 1989: 360, translation of *Nik* 1, 142.

²⁵ See Powell 1994: 100-101.

²⁶ This assumption has been challenged by Stol 1990: 325-326, who argues that contrary to common beliefs the production of “bappir” and further barley ingredients of beer may well have included a germination process so that grain was used for brewing only in germinated form, as in modern beer brewing technology.

period

§5.1. At the end of the 3rd millennium BC the Ur III dynasty ruled for approximately one hundred years over the territory of Mesopotamia. The Sumerians established, after an interruption by the Old Akkadian period, an empire which temporarily encompassed all of the former city states in the Mesopotamian plane. Sumerian culture dominated Mesopotamia in this so-called neo-Sumerian period for the last time before the Sumerians finally disappeared as an identifiable population. Only their language was preserved by Babylonian scribes who cultivated its further use as an esoteric art bearing witness to their sophisticated literacy.

§5.2. The empire ruled by kings of the third dynasty of Ur was administrated in a similar way to the previously much smaller city states. A hypertrophic bureaucracy tried to keep control over the economic resources of the huge empire.²⁷ The number of administrative documents from the neo-Sumerian period which survived in museum collections and in the treasure chests of private collectors all over the world can only be roughly estimated. This number must be well over 100,000, given that the texts compiled in the CDLI amount to more than 92,000 tablets.

§5.3. Several thousands of individual entries of these accounts document that “beer” (kaš) or its ingredients were delivered or received.²⁸ The registered amounts were usually denoted using the neo-Sumerian system of capacity measures. This system was based on the measure “sila₃” (approximately 1 liter). The “ban₂” contained 10 “sila₃”, the “barig” 6 “ban₂”, and the “gur” 5 “barig” (i.e. approximately 300 liters). Sometimes, however, the quantities of beer were denoted in a different way: they were registered by counting the number of beer jugs (dug) which probably had a standard size of 2 “ban₂.”²⁹ The use of this variant metrology was possibly indicated by adding the sign “DUG” after the

figure for the number of jugs.

§5.4. Beer registered in the accounting documents was mostly further qualified as “ordinary” beer (kaš du), as “good” beer (kaš saga), or by adding a capacity measure between two and four “ban₂” indicating somehow its value or quality by an amount of grain in a certain capacity unit (kaš 2(ban₂), kaš 3(ban₂), or kaš 4(ban₂)). It will be argued in the following that this underlying unit had the size of one beer jug, that is, of 2 “ban₂.” In some cases, entries designated simply as beer and totalled at the end were specified further in this total as “ordinary” beer. This seems to indicate that the designation “kaš” without further specification was an abbreviated form of “kaš du.”³⁰

§5.5. Given the high number of extant neo-Sumerian documents that concern the production and distribution of beer, one would expect that for this period it is much easier to gain information about beer brewing technology than for the earlier Sumerian tradition. This, however, is not true in general. The neo-Sumerian accounting practice was highly standardized as was probably the case even with the brewing technology itself, at least in larger production units. This makes it difficult to derive information about the specific context of beer production from accounting documents of this period. In contrast to texts from earlier periods, the majority of the enormous number of these documents does not provide information about beer types, beer ingredients and intermediate substances of the production process.

§5.6. In principle, information about the production of beer in the neo-Sumerian period can be derived from the metrology used to record various related products, from the subsumption of different entries under more general categories, from conversions of entries into common standards in order to make them comparable, and in particular from accounts of the total production of breweries over certain time periods.

§5.7. The latter accounts balance all inputs of the production process during that period with the products

with these products in the same text, but registered here using capacity measures so that it is not certain that the jugs for these products were also the same size. As will become clear in the following, it is nevertheless plausible that these jugs were always the same size.

³⁰ The following texts contain totals which show that “kaš” was an abbreviated form of “kaš du”: Aleppo 21 and 34; *MVN* 2, 247 and 248; *MVN* 14, 237 and 545; *MVN* 16, 702 and 703; *SACT* 2, 292.

²⁷ For a detailed study of the neo-Sumerian accounting system see England 1990.

²⁸ For the role of beer in the neo-Sumerian economy see Neumann 1994.

²⁹ For an indubitable example of counted jugs of beer see *BCT* 1, 131. This document lists deliveries of “kaš du” summing up to 85 1/2 jugs registered sexagesimally. The size of a jug can be inferred consistently for the products “dida du” and “dida saga” (see below) from the entries of the texts *MVN* 17, 9 and *MVN* 5, 233 and is explicitly given for a jug of “dida du” in the text *Hirose* 322. The beer types “kaš du” and “kaš saga” are listed together

delivered to other institutions. They should thus provide at least statistical information about beer and its ingredients. Unfortunately, however, even such balanced accounts of the neo-Sumerian period provide only a very general picture. Essentially they provide evidence of the trivial fact that beer was brewed predominantly from barley and that mainly the two types of beer designated as “ordinary beer” (kaš du) and “good beer” (kaš saga) were produced.

§5.8. One of these accounts for instance,³¹ which is particularly well preserved, balances a debit against the produced beer registered in the credit section. The debit consisted essentially of a deficit from the previous accounting period³² amounting to a value of more than seven hundred “gur” of barley (about 2100 hectoliters [210,000 liters]) and of various entries about barley received during two consecutive months amounting altogether to approximately 1,400 “gur” (about 4200 hectoliters). The credit section contains entries about various deliveries of beer designated either as “ordinary beer” or as “good beer,” with one exception concerning a beer designated as “kaš 4(ban₂).” The quantities of these deliveries of beer amount to a total of nearly 1,000 “gur” (about 3000 hectoliters).

§5.9. Given such a huge input of barley and output of beer, only a few further entries from the document seem to be statistically significant enough to provide further information about the brewing process. The credit section of delivered products contains some entries about a product called kaš or dug “dida₍₂₎ (=U₂(/US₂)-SA),” further qualified either as “ordinary” (dida du) or as “good” (dida saga). However, these entries for both types together amount to less than 50 “gur” (less than 150 hectoliters). Another product occurring in the account was a special type of barley groats, again represented by the sign GAR (usually read “ninda”).³³ Entries qualified as “ordinary ground barley groats” (GAR ar₃-ra du) amounting to less than 60 “gur” (less

than 180 hectoliters) are recorded in the debit section of input materials, and entries qualified as “good ground barley groats” (GAR ar₃-ra saga) amounting to 25 “gur” (circa 75 hectoliters) are recorded in the credit section of deliveries. All other entries of the document appear to be even less significant. None of the further entries of the debit section of input materials exceed the amount of one “barig,” that is, of one fifth of a “gur.” In the credit section, some entries concern somewhat greater amounts of deliveries, but none of them in the order of the amounts of the delivered beer. About one “gur” of “porridge of malt” (ba-ba munu₄, malt now designated by the sign composite BULUG₃×ŠE, read munu₄) has been delivered and also a similar amount of a product designated as “dabin kaš saga,” probably a kind of good beer produced from a special type of flour (dabin). Finally, some deliveries of a substance which was probably “bappir” (sign ŠIM, read bappir₂) are registered, about one “gur” qualified as “good” (bappir₂ saga), about 10 “gur” qualified as “good, crushed” (bappir₂ saga gaz). Given the relatively small amounts of all these additional deliveries they can represent only by-products of the process of brewing two types of beer from barley, products which only occasionally were delivered by themselves.

§5.10. Another well-preserved, balanced account³⁴ supports this general picture, although in this case the

evidence, thus appears as misleading at the least. In all likelihood, “GAR” represents in the neo-Sumerian period a generic term for various types of groats, further qualified according to the type of grain, the quality and degree of grinding, and the nature of further treatment. Examples of such qualifications are “ordinary groats” (GAR du), “good groats” (GAR saga), “flour from(?) groats” (GAR zi₃), “light(?) flour from(?) groats” (GAR zi₃ sig₁₅), “groats from(?) dehusked emmer” (GAR imgaga₃), “(?)... groats” (GAR GIŠ AŠ), “ground groats” (GAR ar₃-ra), “ordinary ground groats” (GAR ar₃-ra du), “good ground groats” (GAR ar₃-ra saga), “ground groats from(?) emmer” (GAR ar₃-ra ziz₂) etc. The totals of *SACT* 2, 292, suggest, that “GAR” without further qualification is the same as “GAR du.” The various types of groats were mainly produced in specialized milling workshops. Only “ground groats” (GAR ar₃-ra) seem also to have been produced in substantial amounts in breweries. Based on the later tradition of lexical texts, “GAR ar₃-ra” is usually read “nig₂ ar₃-ra,” and not “ninda ar₃-ra” as one would expect given that the barley product “GAR” is usually read “ninda,” but this different reading obscures the close relation to the generic term “GAR.”

³⁴ *MVN* 12, 305. Another example is an account of a brewer with the name “Ur-mes,” the text *MVN* 17, 9. The

³¹ *CT* 3, pl. 48, BM 21340.

³² This transfer of deficits from one period to the next shows that the Sumerians used, at least in this period, a system of continuous bookkeeping. Such debts could be transferred to the next period as in the present case, they could be settled at some time by delivering an extra amount of products, or they could be cashed in silver; see, for example, *Aleppo* 444.

³³ Thousands of entries of neo-Sumerian accounting documents register deliveries of “GAR.” Nearly all of them use capacity measures. The common translation as “bread” (read ninda), which is based on later

amounts of barley in the debit section and of beer in the credit section are much smaller than in the previous document. In this case, the section about the input materials contains only two entries which together represent 32 “gur” of barley (about 96 hectoliters). Apart from some small deliveries of barley itself, the credit section contains only entries about four types of products which are precisely those occurring in relevant amounts in the account previously discussed. The main deliveries were those of “ordinary” and of “good” beer, complemented again by a small amount of “good beer (containing) 4 (ban₂ of barley)” (kaš 4(ban₂) saga). The fourth type of product was good “dida” (dida saga), which was, however, converted here for administrative purposes into good beer (kaš saga) by adding one third of its volume.

§5.11. In summary, while comparable documents from the Old Sumerian period often provide information about beer ingredients, the neo-Sumerian balanced accounts of breweries contain in their debit section primarily unprocessed barley received from central granaries³⁵ and not ingredients such as malt and “bappir.” This absence of intermediate products is probably a consequence of the standardization and integration of the process of beer production in this period. It is likely that preparatory steps such as crushing and malting of barley were now performed in the “breweries” themselves. Accordingly, the two main ingredients of Sumerian beer, malt and “bappir” (written now BULUG₃×ŠE, read munu₄, and ŠIM×GAR, read bappir, or simply ŠIM, read bappir₂), no longer occur as raw materials delivered to breweries but only occasionally in other types of accounting documents.

§5.12. In contrast to this disappearance of major ingredients of Sumerian beer from certain neo-Sumerian accounting documents due to a modified organization of the production process, other differences to Old Sumerian records of beer production may really indicate that changes in the brewing technology itself had taken place. Emmer, for instance, was a main ingredient of one of the Old Sumerian beer types, but it was obviously no longer an ingredient of any of the major types of neo-Sumerian beer. Furthermore, the intermediate

brewer received mainly barley (more than 100 “gur”), but also ordinary and good beer (less than 20 “gur”). He delivered each day for 13 months 30 sila₃ (one tenth of one “gur”) of each type of beer and a further total of about 100 jugs of ordinary and good “dida.”

³⁵ See e.g. *MVN* 6, 285 with a delivery of 40 gur to the brewer “e-a-mu” and of 70 gur to the brewer Ur-Asari.”

barley product “titab” disappeared entirely from accounting documents of this period. It may be no coincidence that a new product, the above-mentioned substance (kaš or dug) “dida₍₂₎,” is recorded in hundreds of entries of neo-Sumerian accounting documents. Alone the fact that “dida” was recorded as a qualification of the drink represented by the sign “KAŠ” for beer or the sign “DUG” for a vessel or beer jug indicates its close connection to beer brewing. The accounts from breweries show moreover that “dida” was produced together with beer, either as a specific type of beer, or as an intermediate product which was not only used in the process of beer production within the breweries, but was also consumed or otherwise used.

§5.13. The products qualified by “dida₍₂₎” exhibit a great variety of designations for different types. It has been mentioned above that “dida₍₂₎” was recorded following either the sign “KAŠ” or the sign “DUG.” The similarity of these signs makes it sometimes difficult to clearly distinguish them, but the frequent occurrences of kaš and kaš dida on the same tablet provide clear evidence for the fact that “dida” was not simply a term for beer. This variation seems, however, to have had no bearing whatsoever on the meaning of the sign combination representing “dida₍₂₎.”³⁶

§5.14. On the other hand, further qualifications of “dida₍₂₎” clearly indicated different products. In the same way as beer itself, “dida₍₂₎” could be qualified as “ordinary” (dida₍₂₎ du) or “good” (dida₍₂₎ saga) or be complemented with a capacity measure indicating its value or quality (e.g. dida₍₂₎ 2(ban₂)). Occasionally, “dida₍₂₎” was furthermore combined with the sign combination “ZIZ₂-AN” (read imgaga₃) probably designating dehusked emmer (dug dida₍₂₎ imgaga₃).³⁷ The metrology used to register the quantities of “kaš dida₍₂₎” varied like

³⁶ See e.g. *MVN* 13, 771 for using the same sign for beer and for “dida” and *MVN* 5, 233 for evidently using different signs. The texts *MVN* 14, 237, 243, and 266, use both renderings on the same tablet providing evidence of the equality of their meaning. The whole issue of rendering “dida” is obscured by the fact that in the handbook of Borger and Ellermeier, “dida” is proposed as designation for the sign combination “KAŠ-US₂-SA,” but many scholars, including the CDLI (and Borger is ambiguous in *MeZL* p. 476), prefer “dida” as designation for “U₂-SA” and dida₂ for “US₂-SA” alone, adding “dug” or “kaš” corresponding to the actual rendering of “dida” with the signs “DUG” or “KAŠ,” respectively. Here, we follow the convention of CDLI.

³⁷ See *MVN* 12, 80 and 111; *TLB* 3, 29.

that for beer, either applying capacity measures or, more often than in the case of beer, by counting numbers of jugs with a capacity of 2 “ban₂.”³⁸ Confusingly, the unit used for denoting numbers of jugs is often not the usual vertical unit sign “DIŠ” but rather the horizontal unit sign “AŠ” used otherwise for the capacity unit “gur.”³⁹ Moreover, in contrast to the qualifications of beer itself, the different qualifications of “dida₍₂₎” occur in various combinations together with each other, forming a puzzling complexity of designations such as, for instance, “kaš dida₍₂₎ imgaga₃ 2(ban₂)-ta” or of “kaš dida₍₂₎ du 1(ban₂) 5(diš) sila₃” and “kaš dida₍₂₎ saga 1(ban₂) 5(diš) sila₃” in the same text.⁴⁰

§5.15. The designation as ordinary (kaš dida₍₂₎ du) or as good (kaš dida₍₂₎ saga) was thus to a certain extent independent of the qualification by a capacity measure of ingredients per unit of “kaš dida₍₂₎,” which varied over a different range than in the case of beer using the values “kaš dida₍₂₎ 1(ban₂),” “kaš dida₍₂₎ 1(ban₂) 5 sila₃,” “kaš dida₍₂₎ 2(ban₂),” and “kaš dida₍₂₎ 3(ban₂).” But the qualification as ordinary was predominantly combined with capacity measures between one and two “ban₂,” the qualification as “good” with measures between two and three “ban₂.” This was, however, not a rigid rule and designations also exist such as “kaš dida du 3(ban₂).”⁴¹

§5.16. An analysis of the relations between individual

³⁸ For an example of “dida” registered by capacity measures see *MVN* 13, 380. An indubitable example of 47 counted jugs of “dida saga” and of 23 jugs of “dida du” with a capacity of 2 ban₂ each is provided by *MVN* 17, 9; see below about the conversion of amounts of “dida” into grain values.

³⁹ The variant rendering of the unit seems to be a particularity of the city of Girsu. The local variation of metrologies in the 4th millennium BC deserves a detailed study.

⁴⁰ See *TLB* 3, 29 obv. 2 and *MVN* 14, 593 obv. 3 and 4. See also *CT* 5, pl. 47, BM 19742 obv. iii 4-6 with the complex qualifications of counted jars “dida imgaga₃ dug 3(ban₂) 3(barig) 3(ban₂)-ta” and “dida saga dug 3(ban₂) 1(barig) 4(ban₂) 5(diš) sila₃-ta” followed by the amount of corresponding barley calculated by multiplying the qualifications (or sizes?) “3(barig) 3(ban₂)” and “1(barig) 4(ban₂) 5(diš) sila₃” with the respective numbers of jars.

⁴¹ It is particularly puzzling that sometimes ordinary “dida” occurs with a higher capacity measure than good “dida” in the same text. In the first line of the text *MVN* 14, 256, are registered 2 jugs of “dida saga 2(ban₂)” and in the following line 6 jugs of “dida du 3(ban₂).” The text *MVN* 16, 707 contains in the first three lines

entries concerning “kaš dida” and totals of such entries which sometimes were more precisely specified yields a similarly confusing picture. There are, in particular, many examples of totals of “kaš dida₍₂₎” designating them more precisely as “kaš dida₍₂₎ du,” as “kaš dida 1(ban₂),” or as “kaš dida₍₂₎ du 1(ban₂).” But there is also a text specifying “kaš dida₍₂₎” differently as “kaš dida₍₂₎ du 2(ban₂)”⁴² and another text specifying “kaš dida₍₂₎ saga” as “kaš dida₍₂₎ saga 1(ban₂) 5 sila₃.”⁴³

§5.17. Some clarification of confusing qualifications of beer and “kaš dida₍₂₎” can be gained from the conversion of these products into capacity measures of barley, which represent their value when comparing them in balanced accounts. Such barley capacity measures need not have any physical meaning. The conversion of emmer into barley, for instance, does not mean that anybody could physically transform one grain species into another. Mostly, however, the conversion of the amounts of a barley product into barley capacity measures by multiplying them with a specific factor may really reflect to a certain extent the amount of raw material required for their production (confer now Brunke 2011; Englund 2011).

§5.18. Two methods were used to denote the value of a product. The first method was to record directly the amount of barley corresponding to a given amount of the product. This method was indicated by the phrase “its barley ...” (še-bi ...) in front of the amount of barley representing the value. The second method was to record an amount that had to be added to the original amount in order to get its value. This method was indicated by the phrase “its barley conversion ...” (še bala-bi ...) followed by the amount that had to be added in order to convert the given amount of the product into the amount of barley representing its value.

§5.19. Both methods were only used with simple factors such as one, one-half, one-third, or one-tenth of the amount to be added. Products with the same value

entries about “dida saga 2(ban₂),” “dida du 3(ban₂),” and “dida du 1(ban₂) 5 sila₃.” Obviously, the distinction between “good” and “ordinary” is here independent of the amount specified by the capacity measure, either because this distinction has nothing to do with the amount of grain in the unit, or because the capacity measure here has another meaning, e.g., it refers in these cases to the size of the jug and not to the quality of its content.

⁴² See *Hirose* 390.

⁴³ See *BCT* 1, 131.

were usually grouped and totalled before the amounts were converted, so that the calculation of the conversion could be performed for the whole group at once. Furthermore, both methods could be used also with other value standards than barley. In particular, the calculation of the value of a certain amount of a product could be first converted into one or more intermediate products before being converted into the final value standard. Good “dida” (dida saga), for instance, was, in a initial stage of calculation, converted into good beer (kaš saga) by adding one third of the amount, designated as “its good beer conversion ...” (kaš saga bala-bi ...). Then, in order to determine the final barley value, both amounts were added up with other entries of products with the same value as good beer, and one half of that total, designated as “its barley conversion ...” (še bala-bi ...), was added.

§5.20. Since the conversion factors were always very simple, the beer types and ingredients can easily be grouped according to their value.⁴⁴ Several of these products had a value such that the amount of the product equalled the amount of barley representing its value so that no calculation was necessary. Such products were the ordinary beer (kaš du), the beer qualified as representing two “ban₂” (kaš 2(ban₂)), and the ordinary ground barley groats (GAR ar₃-ra du). One half had to be added to the amounts of good beer (kaš saga), of beer qualified as representing three “ban₂” (kaš 3(ban₂)), and of good ground barley groats (GAR ar₃-ra saga). The amount had to be doubled to calculate the value of beer qualified as representing four “ban₂” (kaš 4(ban₂)), and of porridge of malt (ba-ba munu₄).

§5.21. The relation between the conversion factors and the designations of the products allows some conclusions concerning the meaning of these terms. There is a consistent correspondence between the designations and the corresponding values, both for the qualification

⁴⁴ The values of the conversion factors need a thorough study. The values given here are reconstructed from the following texts: *MVN* 5, 233; *MVN* 6, 255; *MVN* 12, 305; *MVN* 13, 380; *MVN* 15, 91; *MVN* 16, 747; *MVN* 17, 65; *CT* 3, pl. 15, BM 13897, pl. 27, BM 19027, pl. 44, BM 21338, and pl. 48, BM 21340. As a rule, these factors are implicit and have to be calculated from the given, sometimes emended figures, but some texts record such factors explicitly; see e.g. *MVN* 13, 236, lines 10'-11' for “good GAR”: “su+nigin₂ 1(aš) 3(barig) 3(ban₂) 8 sila₃ GAR saga / igi 5 gal₂-bi 1 (barig) 4(ban₂) 3 1/2 sila₃ 6 gin₂ gur” (total 1 gur 3 barig 3 ban₂ 8 sila₃ good GAR; its one-fifth: 1 barig 4 ban₂ 3 1/2 sila₃ 6 shekels).

as “ordinary” or “good” and the qualification by capacity measures. These capacity measures turn out to be the barley equivalent to a standard jug of beer which had a capacity of 2 “ban₂.” Given that the different qualifications of beer as “ordinary” or “good” and the qualification by capacity measures seldom or possibly never occur on the same tablet, it is even likely that they did not designate different products. It may well be that the capacity measures just specified literally and with more distinguished steps the qualities of different beer types than the simple distinction between “ordinary” and “good.”

§5.22. The situation is more complex in the cases of “dida” and “bappir.” The two dida types “dida du” and “dida saga,” for which conversion examples are known, were first converted by adding one third of the amount into the values of the corresponding beer types “kaš du” and “kaš saga.” Afterwards they were handled together with entries of these beers. Since the barley value of “kaš du” equalled its amount, the barley value of “dida du” remained therefore four thirds of the amount of “dida,” while again one half had to be added to the “kaš saga” value of “dida saga” so that its final value became double the original amount of “dida.” The fact that this simple conversion factor was not applied directly but step by step and thus by more complicated calculations strongly suggests that “dida” could really be transformed into a beer corresponding to its quality, either because it could be diluted by adding water corresponding to one third of its volume or because it was a storable intermediate product with a higher value than the beer it finally produced.

§5.23. In contrast to this two-stage conversion of amounts of ordinary and good “dida” into their barley values, the qualifications of “dida” by capacity measures indicating their values or qualities were directly related to their values. Each jug of “dida 2(ban₂)” was converted into 2 ban₂, each jug of “dida 3(ban₂)” into 3 ban₂ of barley.

§5.24. Even more complex is the situation in the case of “bappir” represented in the neo-Sumerian period both by the sign “ŠIM” (notation: bappir₂) as well as by the sign combination “ŠIM×GAR” (notation: bappir). A difficulty arises from the fact that already in this period as in later times the sign “ŠIM×GAR” seems to have been used in a generalized way as a term for various kinds of aromatic substances so that its precise meaning can be determined only from the context of its use. Some qualifications of “bappir” such as “crushed good

bappir” (bappir₂ saga gaz_x(KUM))⁴⁵ or “flour of/for(?) bappir₂” (zi₃ bappir₂) clearly refer to the barley product, but their precise role in brewing beer remains an open question. Furthermore, different measures were used for “bappir.” Mostly, amounts of “bappir” were measured by means of capacity measures, but sometimes weight measures were applied⁴⁶ and in an exceptional text “bappir” was even counted.⁴⁷

§5.25. Reliable data for a reconstruction of conversion factors exist for good “bappir” (ŠIM saga and ŠIM×GAR saga) and for crushed good “bappir” (ŠIM saga gaz).⁴⁸ Good “bappir” was first converted by adding one tenth of its amount and grouping it afterwards with products such as “kaš saga” or “GAR ar₃-ra saga” which were converted by adding one half of their amounts. Crushed good “bappir” was treated together with good “bappir” in the same way, after first converting its amount by doubling it into an equivalent amount of good “bappir.”

§5.26. The addition of one tenth to the amount of good “bappir” was designated as “its laḥtan₂ content” (ša₃ laḥtan₂-bi ...). The term “laḥtan₂” is usually considered a technical term for the collector vat into which the beer is filtered after fermentation through a spout at the bottom of a fermenting vessel—a vessel which is probably depicted by the sign “ŠIM.” It is tempting to derive from this connection direct indications for the function of “bappir” in the brewing process and to interpret the addition of one tenth of its amount as compensation for the use of the vessel “laḥtan₂.” However, since this would be the only example of including the value of a container into the value calculation and since the “laḥtan₂” conversion is not applied to other “bappir” than that of good quality, it seems more reasonable to assume that “laḥtan₂” designates here not a vessel but rather a special treatment that increased the value of “bappir saga” in comparison to the unprocessed barley it was probably made of.

§5.27. Unfortunately, for other types of “bappir” than that of good quality the extant sources provide, partly

due to problematic reconstructions of damaged parts, only inconsistent information. One of the texts, for instance,⁴⁹ has an entry about a certain amount of “bappir₂” (sign ŠIM), but in the list of totals this entry is designated as “kaš 4(ban₂)” and the value is calculated using the conversion factor of this type of beer, that is, to double the amount. It is an open question whether this treatment has to be interpreted simply as an error of the scribe or rather as an indication that both designations denote products with the same value or even of a similar nature. Another text⁵⁰ contains two times calculations of the barley value from “bappir” (sign ŠIM×GAR) registered in weight measures, but both times using different conversion factors.⁵¹ In a further text “bappir” (qualification unsure due to damage) is handled together with good ground barley groats (GAR ar₃-ra saga)⁵² thus using again a different conversion factor, that is, to add one half of the amount. Finally, the exceptional text in which “bappir” is counted⁵³ contains implicitly the assumption that each delivered unit of “bappir” corresponds to 7.5 sila₃ of barley.

§5.28. The high number of neo-Sumerian accounting documents provide us with abundant information about the production and distribution of beer in this period, but, as these examples show, not with the information required to understand them. In particular, no reliable relation beyond philological continuity can be established between the neo-Sumerian beer types and ingredients of earlier periods. This philological continuity can be as misleading in the same way as the ideographic tradition of using specific signs for certain beer types and ingredients. The enigmatic history of signs such as “GAR” and “ŠIM” provides telling examples which make this problem evident. The techniques of bookkeeping have been widely changed from the first proto-cuneiform accounting documents to the neo-Sumerian system of economic administration. It is difficult to trace the ideographic and terminological changes connected with this development from the early representation of real products and activities by symbols to an accounting system based on abstract eco-

⁴⁵ See *MVN* 13, 131 and 132.

⁴⁶ See *MVN* 11, AA, and *MVN* 16, 747; possibly also “bappir” and not other aromatics: *MVN* 13, 377 and *MVN* 14, 31.

⁴⁷ *MVN* 12, 502.

⁴⁸ The argument is based on an analysis of the following texts: *CT* 3, pl. 44, BM 21338 and pl. 48, BM 21340; *MVN* 13, 835; *MVN* 16, 747; and *MVN* 17, 65.

⁴⁹ *CT* 3, pl. 48, BM 21340.

⁵⁰ *MVN* 16, 747.

⁵¹ If in the published transliteration the readings of the damaged parts are correct, lines 1 to 2 imply that 2 “mana” of “bappir₂” have a value of 3 “sila₃” barley, but lines 10 to 11 imply that 5 “mana” of “bappir₂” have a value of 6 “sila₃” barley.

⁵² *MVN* 17, 65 obv. 2-3.

⁵³ *MVN* 12, 502.

conomic values. While it is obvious that this development was accompanied by corresponding changes of the social organization of political and economic control, it is nearly impossible to say to what extent such changes also involved technological innovations in the production process. Numerous neo-Sumerian administrative documents concern the human skills and workmanship involved in the development of the technology of brewing beer. A crucial prerequisite, however, for drawing reliable conclusions from these documents is independent information about the context of the documented activities from sources other than accounting documents.

§6. The brewing of beer

§6.1. Let us therefore finally turn to the main source of our knowledge of the process of brewing the beer itself which is, as mentioned at the beginning, the Hymn to Ninkasi. The poetic character of this hymn is obvious from its content as well as its form. Its content essentially praises the goddess Ninkasi. Its form exhibits repetitions of each two lines as if the text was meant to be a song. The part related to the brewing process begins with the third strophe. With the repetitions left out, the text in the translation of its standard edition⁵⁴ is as follows:

Ninkasi, you are the one who handles dough (and) ... with a big shovel,
Mixing, in a pit, the bappir with sweet aromatics.
Ninkasi, you are the one who bakes the bappir in the big oven,
Puts in order the piles of hulled grain.
Ninkasi, you are the one who waters the earth-covered malt ("munu"),
The noble dogs guard (it even) from the potentates.
Ninkasi, you are the one who soaks the malt ("sun₂") in a jar,
The waves rise, the waves fall.
Ninkasi, you are the one who spreads the cooked mash ("titab") on large reed mats,
Coolness overcomes ...
Ninkasi, you are the one who holds with both hands the great sweetwort ("dida"),
Brewing (it) with honey (and) wine.
Ninkasi, [...]
[You ...] the sweetwort ("dida") to the vessel.
The fermenting vat, which makes a pleasant sound,
You place appropriately on (top of) a large collector vat ("lahhan").
Ninkasi, you are the one who pours out the filtered beer of the collector vat,
It is (like) the onrush of the Tigris and the Euphrates.

§6.2. According to the interpretation represented by

this translation, which is currently accepted among most scholars working on cuneiform literature, brewing began with two processes, the preparation of "bappir," the term of which is left untranslated here, and the soaking and germination of malt. The next step was the preparation of the mash, its cooking and cooling. Finally the wort was prepared and fermented. When the beer was ready, it was filtered from the fermentation vat into a collector vat from which it was poured for consumption.

§6.3. A number of details are implied by this interpretation. For the production of "bappir" a dough must have been prepared by mixing grain with aromatic herbs. The mixture must have been then baked in an oven. For the preparation of malt, grain must have been germinated by spreading it out, covering it with earth, and watering it. After soaking the malt in a jar, the hymn mentions "waves that rise and fall." This passage suggests that the fluid in the jar resulting from soaking the malt pulsed in waves as a result of the mashing process. The resulting "titab" was again spread out on reed mats for cooling and drying. In dried form, this intermediate product may have been suitable for storage. It may thus have been in fact the "titab" which occurs in administrative texts as an ingredient of beer. After these preparatory steps and the mixing with aromatics, the process of fermentation must have taken place in a dedicated type of vessel. This vessel seems to have had an opening at the bottom through which the beer was filtered into another vessel used for storage until consumption.

§6.4. Such an interpretation of the Hymn to Ninkasi as representing the steps of the brewing process is hardly possible without applying modern knowledge of the chemistry of brewing. Given that many passages of the text are obscure, the translation is influenced to a considerable extent by knowledge about modern brewing technology.

§6.5. In particular, the text does not unambiguously clarify the strophes of the hymn as following the stages of the brewing process in their natural order. Their interpretation as a sequence of consecutive steps is based on the assumption that the ingredients malt (reading munu₃), "sun₂" (in the standard edition also translated as "malt"), and "titab" designated three successive stages of the same ingredient. Given that in Old Sumerian texts malt and "titab" were registered as independent ingredients, such an interpretation requires the further assumption of a considerable flexibility of these designations or of the brewing technique itself.

⁵⁴ Civil 1964; Sumerian terms added in parentheses.

§6.6. Furthermore, the sequence of steps is incomplete. The hymn does not say how the germination process was stopped at the right point. Usually, it is assumed that the barley was shovelled into heaps and a heating and drying process used to stop germination when the sprouts attained to the required size, but nothing like that is mentioned in the hymn. The mashing process is indicated by the “waves that rise and fall,” but it is not mentioned that such a process requires some kind of heating. The interpretation further assumes that the hymn describes rather independently from each other the preparation of “bappir” and of malt, but the question at which stage of the alleged procedure “bappir” and malt were brought together remains unanswered. The opinions on this point differ considerably in the scholarly literature. It has even been suggested that the ingredient “dida,” well known from administrative documents and mentioned also in the hymn (translated here as “sweetwort”), is not a further ingredient to sweeten the beer as is usually assumed,⁵⁵ but precisely the mixture of “titab” and “bappir”⁵⁶ missing in the hymn from which the final wort for fermentation might have been prepared.

§6.7. Some of the alleged steps of the brewing process find confirmation in other literary references to brewing. According to the Sumerian disputation “Lahar and Ashnan,” for instance, Ninkasi, when she brewed beer for a banquet, mixed “bappir” and “titab” after preparing both ingredients in an oven. Nevertheless, it cannot be excluded that the interpretation of the poetic wording of the hymn in terms of modern knowledge about the chemistry of brewing technology resulted in a number of anachronistic projections which have to fill the gaps of the scarce knowledge provided by extant sources.

§6.8. This interpretation is the more suspicious as it cannot easily be reconciled with the information gained from neo-Sumerian accounting documents. While the complete absence of “titab” in these documents may be explained as an indication that “titab” was in this period only an intermediate product of the brewing process without any other use, it is hardly conceivable that the “dida” which supposedly was kept as a liquid in beer jugs could be the same as the one Ninkasi holds with both hands as the “sweetwort” to be added to the fer-

menting vat or, if interpreted as mixture of “titab” and “bappir”, to be soaked as the major ingredient of the wort to be fermented.

§6.9. In any case, even if the global view of the brewing process achieved from the interpretation of the hymn should be essentially correct, too many questions remain open as that the nature of the ingredients of Sumerian beer, the brewing process, and the types of beer produced can be considered as satisfactorily known.

§6.10. The identification of activities of brewing beer in the Hymn to Ninkasi is predominantly based on the interpretation of the text according to philological criteria, and the identification of the meaning of terms related to brewing activities with that of modern brewing terminology. By contrast, the above mentioned study (Zarnkow et al. 2006) on beer brewing activities at Tall Bazi is based on combining the interpretation of archaeological finds with brewing experiments using local sources and brewing devices.

§6.11. Apparently, the success of brewing at Tall Bazi was dependent on local conditions. The temperature in the houses could be kept at a constant 24 degrees Celsius. This made it possible that the two-row barley (*hordeum vulgare*), residuals of which could be identified in vessels found in the houses, easily germinated after the approximately one-year latency period of the grain. Stirred twice a day, the grain needed four days for an optimal yield of amylolytic enzymes to decompose starch into sugar. The produced green malt, however, could not be stored for a long period, and it was, furthermore, too moist to be ground with the saddle querns that were common in Mesopotamia, and that at Tall Bazi belonged to the basic inventory of household tools. It is, therefore, likely that the green malt was dried before grinding. Experiments showed that a temperature of 60 degrees Celsius, easily be reached during the summer months on the roofs of the houses, was sufficient to dry the malt as if it had been kiln-dried. The dried malt achieved this way turned out to be rich in amylolytic enzymes. It could easily be ground with saddle querns and did not deteriorate over a long period of time.

§6.12. The detection of residues of oxalate as well as of tartrate inside the wide-mouthed vessels with a hole in the bottom suggests that they were used for multiple purposes. They proved to be particularly useful as containers for the soaked barley. The soaked or germinated grain could be pressed through the hole in the bottom

⁵⁵ Röllig 1970: 25, 40-42.

⁵⁶ Stol 1971 in his review of Röllig 1970.

to be spread out on reed mats for drying in order to stop the germination process, and to produce a stable and grindable kind of dried malt.

§6.13. Since it is known that Sumerian beer was produced not only from germinated barley but also from otherwise processed grain, procedures were investigated that could ensure that the starch of such ingredients could sufficiently be decomposed into sugar by amylolytic enzymes contained in the malt. Such a procedure had to agglutinate the starch in the same way that it occurs, for instance, in the process of producing bulgur (parboiled and dried wheat). It also happens in the process of producing bread. Experiments of the Tall Bazi project employing modern analytical methods showed that, aside from germinating, the best rate of yield was achieved by boiling barley groats. The authors of the study concluded, however, that, due to a shortage of heating material at Tall Bazi, and since the ovens that were archaeologically attested there were suitable only for the production of pita bread, it is most likely that the beer production there was exclusively based on germinated grain.

§6.14. Mashing and fermentation did probably take place in the big vessels half buried in the floors of the houses. This archaeologically plausible condition implies the application of a cold mashing method. Ground malt and water was mixed in a proportion of approximately 1 to 8. It is noteworthy that this relation was probably deliberately chosen in order to produce a beer with a low percentage of alcohol; as a staple foodstuff in ancient Mesopotamia, beer was evidently consumed by laborers as well as priests and kings, and it has been argued that this drink, in particular that known as *kaš du*, “regular beer,” was more akin to Slavic *kvass*, with an alcohol content of usually less than 1%, than to modern brews achieving, again as a rule, a strength of from 4-6%. The strength of Babylonian beer could be manipulated by changing this ground malt : water relation.

§6.15. The mash was stirred for 15 minutes at about 34 degrees Celsius. Afterwards, the fermentation was initiated by adding a yeast that made a mixture of alcoholic and lactic fermentation possible. Such a mixture may have originally resulted from spontaneous fermentation and later by transferring part of the foam of the top-fermented mash from one charge to the next. After 36 hours at 24 degrees the procedure resulted in a highly fermented, tasty beer that was stable for more than two months.

§6.16. It may be tempting to confront straightforwardly the philological approach of interpreting historically transmitted texts such as the Hymn to Ninkasi with the experimental-archaeological approach of developing scenarios of how beer in the modern sense could be produced under archaeologically determined ancient contexts such as those of Tall Bazi. Thus, for instance, the philological distinction between the fermentation vat (“*nig₂-dur₂-buru₃*”) and the collector vat (“*laḥtan*”) seems to correspond perfectly with the archaeological distinction between the vessel equipped with a hole in the bottom and the barrel-shaped vessel half buried in the floor. However, this identification leads to contradictions. According to the philological interpretation of the Hymn to Ninkasi, the wort was fermented in the fermentation vat, whereas according to the Tall Bazi study it should have been fermented in the collector vat. Whereas the hymn demonstrates that the wort is something the goddess Ninkasi could hold in her hands, the Tall Bazi study and modern brewing technology presume the wort is a liquid that could not be held, except for a possible metaphorical use of the phrase “holding in her hands.” Moreover, technical terms in the hymn such as “*sun₂*,” “*titab*” or “*dida*,” do not correspond to anything in the Tall Bazi brewing experiment.

§6.17. In many respects, however, a comparison of the interpretation of the Hymn to Ninkasi with the Tall Bazi brewing experiment is problematic. First, there is an historical time lag of about 500 years between the 18th century BC cuneiform sources of the hymn, with its allusions to a sophisticated technology of brewing, and the simple brewing procedure based on the excavated 13th century BC Tall Bazi settlement. Second, disregarding this time difference, there may still be great differences between the local conditions in the Mesopotamian alluvial plane and those at the border of the rain-fed agricultural area in northern Syria where Tall Bazi was situated. Given that the success of certain germinating and fermenting procedures are dependent on local conditions, such differences in time and space may make a direct comparison virtually impossible. Third, while the Hymn to Ninkasi refers to an existing ancient brewing procedure, the Tall Bazi experiment tried to show how a type of beer comparable with the results of modern beer technology could be produced under the conditions at Tall Bazi. Consequently, the authors of the study point out that they only developed a simple cold mashing procedure that would have worked under the conditions of Tall Bazi. They consider their reconstruction as a basic procedure which might have been a starting point for more sophisticated technologies, per-

haps themselves even based on raw materials other than malted barley.

§7. What kind of beer did the Sumerians brew?

§7.1. Such doubts raise, finally, an even more fundamental question: To what extent is it possible to compare ancient foodstuffs or other products with our modern ones? In the case of Sumerian beer, it is unlikely that it was really beer that the Sumerians and their successors prepared from grain and consumed presumably in large amounts.

§7.2. How much alcohol might have been contained in this alleged beer? There are in fact some indications that the Sumerian beer was consumed in similar social contexts as we drink our modern beer. At the end of the hymn, the goddess Ninkasi pours out beer for the drinkers as if she represented not only the brewer and his work but moreover a female tavern-keeper. We know from sources such as the Code of Hammurapi that Sumerian beer was, in fact, consumed in taverns which were often run by women. These taverns were places of amusement, of prostitution, and of crime.⁵⁷ To consume alcoholic drinks such as beer fits the picture of such an environment. It also meets modern expectations of what the intoxicating effect of alcohol might be good for, since ancient beer was consumed in great amounts on the occasion of feasts. Some depictions of erotic scenes also suggest that there was a habit of drinking beer during sexual intercourse.⁵⁸ Even the fact that

beer was distributed as rations among workers does not necessarily contradict the effects we might expect.

§7.3. Nevertheless, there are alternatives to be considered which are equally plausible. Given our limited knowledge of the Sumerian brewing process we do not even know for sure that the resulting product had any alcohol content at all. We really cannot know whether Sumerian beer might after all have had a greater similarity with *kvass* than, say, with German beer, although, as the discussed experimental study shows, even this may be possible. Both possibilities are by no means excluded by the information we can extract from the extant administrative and literary sources and the few brewing experiments performed so far. It is true that far-reaching conclusions can be drawn from the written sources only in combination with our knowledge of the chemistry of brewing. This would, however, require brewing experiments that not only try to conform with archaeological findings, but that also try to bring materials, products and procedures of the brewing process into accord with the terminology and contents of written sources. Moreover, it might be helpful to exploit the available knowledge about indigenous food varieties in different cultures in so far as they still exist in the ever more globalized world. Such interdisciplinary research efforts might well lead to better interpretations of the “Hymn of Ninkasi” than those currently accepted among specialists working on cuneiform literature.

⁵⁷ See Trümpelmann 1981 on the archeological identification of such a tavern.

⁵⁸ See Mazzoni’s comment on the article in Joffe et. al. 1998: 313.

BIBLIOGRAPHY

Bermant, Chaim & Weitzman, Michael

1979 *Ebla: An Archaeological Enigma*. London: Weidenfeld & Nicholson

Alster, Bendt & Vanstiphout, Herman

1987 “Lahar and Asnan: Presentation and Analysis of a Sumerian Disputation.” *Acta Sumerologica* 9, 1-43

Bauer, Josef

1972 *Altsumerische Wirtschaftstexte aus Lagasch. Studia Pobl* 9. Rome: Biblical Institute Press

Braidwood, Robert J., et al.

1953 “Did Man Once Live by Beer Alone?” *American Anthropologist* 55, 515–526

Brunke, Hagan

2011 *Essen in Sumer. Metrologie, Herstellung und Terminologie nach Zeugnis der Ur III-zeitlichen Wirtschaftsurkunden*. München: Herbert Utz Verlag

Civil, Miguel

1964 “A Hymn to the Beer Goddess and a Drinking Song.” In XXX, ed., *From the Workshop of the Chicago Assyrian Dictionary: Studies Presented to A. Leo Oppenheim. AS* 27. Chicago: University of Chicago Press, pp. 67-89

Damerow, Peter & Englund, Robert K.

1987 “Die Zahlzeichensysteme der Archaischen Texte aus Uruk.” In H. J. Nissen & M. W. Green, *Zeichenliste der Archaischen Texte aus Uruk. ATU* 2. Berlin: Gebrüder Mann, pp. 117-166

Englund, Robert K.

1990 *Organisation der Verwaltung der Ur III-Fischerei. BBVO* 10. Berlin: Reimer Verlag

2001 “Grain Accounting Practices in Archaic Mesopotamia.” In J. Høyrup and P. Damerow, eds., *Changing Views on Ancient Near Eastern Mathematics. BBVO* 19. Berlin: Reimer Verlag, pp. 1-36.

2011 “Equivalency Values and the Command Economy of the Ur III Period.” In J. Papadopoulos & G. Urton, eds., *The Construction of Value in the Ancient World*. Los Angeles: Cotsen Institute of Archaeology Press

Englund, Robert K. & Nissen, Hans J.

1993 *Die Lexikalischen Listen der Archaischen Texte aus Uruk. ATU* 3. Berlin: Gebrüder Mann

Hartman, Louis F. & Oppenheim, A. Leo

1950 “On Beer and Brewing Techniques in Ancient Mesopotamia According to the XXIIIrd Tablet of the Series $\text{HAR.ra} = \text{hubullu}$.” *JAOS Supp.* 10. Baltimore: American Oriental Society

Hrozný, Bedřich

1913 *Das Getreide im Alten Babylonien: ein Beitrag zur Kultur- und Wirtschaftsgeschichte des alten Ori-ents. Sitzungsberichte der Kaiserl. Akad. d. Wiss. in Wien. Phil.-hist. Kl.*, Bd. 173 1. Vienna: A. Hölder

Joffe, Alexander H., et al.

1998 “Alcohol and Social Complexity in Ancient Western Asia.” *Current Anthropology* 39, 297-322

Katz, Solomon H. & Maytag, Fritz

1991 “Brewing an Ancient Beer.” *Expedition* 44, 24-33

- Michel, Rudolph H., McGovern, Patrick E. & Badler, Virginia R.
 1992 "Chemical Evidence for Ancient Beer." *Nature* 360/5, 24
- Neumann, Hans
 1994 "Beer as a Means of Compensation for Work in Mesopotamia During the Ur III Period." In L. Milano, ed., *Drinking in Ancient Societies: History and Culture of Drinks in the Ancient Near East: Papers of a Symposium held in Rome, May 17-19, 1990. HANES 6*. Padua: Sargon, pp. 321-331
- Nissen, Hans J.
 1988 *The Early History of Ancient Near East, 9000-2000 BC*. Chicago: University of Chicago Press
- Nissen, Hans J., Damerow, Peter & Englund, Robert K.
 1993 *Archaic Bookkeeping: Early Writing and Techniques of Economic Administration in the Ancient Near East*. Chicago: University of Chicago Press
- Powell, Marvin A.
 1994 "Metron Ariston: Measure as a Tool for Studying Beer in Ancient Mesopotamia." In L. Milano, ed., *Drinking in Ancient Societies: History and Culture of Drinks in the Ancient Near East: Papers of a Symposium held in Rome, May 17-19, 1990. HANES 6*. Padua: Sargon, pp. 91-119
- Röllig, Wolfgang
 1970 *Das Bier im Alten Mesopotamien*. Berlin: Gesellschaft für die Geschichte und Bibliographie des Brauwesens EV
- Selz, Gebhard J.
 1989/1993 *Altsumerische Verwaltungstexte aus Lagaš*. 3 vols. *EAOS* 15/1-3. Stuttgart: Franz Steiner Verlag
- Stol, Martin
 1971 "Zur Altmesopotamischen Bierbereitung." *BiOr* 28/3-4, 167-171
 1990 "Malt." *RLA* 7, 322-329
- Trümpelmann, Leo
 1981 "Eine Kneipe in Susa." *Iranica Antiqua* 16, 35-44
- Wartke, Ralf-Bernhard
 1998 "Bier in den altvorderasiatischen Hochkulturen." In *Gerstensaft und Hirsebier. 5000 Jahre Biergenuß. Kataloge und Schriften des Schloßmuseums Jever*, Heft 19. Oldenburg: Verlag Isensee, pp. 91-108
- Woolley, C. Leonard
 1934 *Ur Excavations II: The Royal Cemetery*. London: The British Museum and the University Museum, University of Pennsylvania
- Zarnkow, Martin, et al.
 2006 "Interdisziplinäre Untersuchungen zum altorientalischen Bierbrauen in der Siedlung von Tell Bazi/Nordsyrien vor rund 3200 Jahren." *Technikgeschichte* 73/1, 3-25