A Computational Approach to Biblical Hebrew Conjugation

Joachim Lambek and Noson S. Yanofsky

November 19, 2006

Abstract

We study the Hebrew verb as it occurs in the Torah, according to the Masoretic tradition. Potentially, each verb has $7 \times 2 \times 10 = 140$ finite conjugational forms corresponding to seven patterns, two tenses and ten persons. We present a simple computational method for generating these conjugational forms step by step.

1 Introduction

In J. Weingreen's authoritative *A Practical Grammar For Classical Hebrew* [11], he writes (page vii) "Hebrew grammar is essentially schematic and, starting from simple primary rules, it is possible to *work out*, almost mathematically, the main groups of word-building." We claim that the adverb "almost" in his assertion can be removed. We shall present such a scheme in a mathematical language. The mathematics involved is that of a finitely generated partially ordered semi-group, also called "semi-Thue system" by mathematicians, "rewrite system" by computer scientists and "production grammar" (Chomsky's Type zero) by linguists.

We do not intend to offer any new discoveries about biblical Hebrew grammar. No new grammatical rule will be introduced, nor will we offer any deep insight that has been overlooked in millennia of work by the Hebrew grammarians. We simply aim at a clear mathematical way of presenting the rules of conjugation for a small fragment of biblical Hebrew. This presentation is concise, exact (perhaps too exact for the text evaluated) and intended to be an easily intelligible expression of the rules. We hope that the rules presented here are an improvement over the usual paradigm tables or the long English statements explaining them. The improvements will be seen with the ease that the examples are computed. We should add that in order to calculate a word form, one always applies the first rewrite rule that is applicable.

We accept the traditional grammar as presented, say, in the admirable text of Weingreen [11], with only minor quibbles. We have also consulted the classical treatment by Gesenius [7]. What we are concerned with is the computational aspect: how could a speaker of biblical Hebrew calculate the correct verb form in a step by step manner? Phonological reasons for some of the grammatical rules will be offered when they are apparent.

While our goal is to be as inclusive as possible, we are ignoring many different parts of Hebrew conjugation. There will be no discussion of the cohortative, imperative, jussive, infinitive, or participle tenses. In general, we ignore the modifications of the verb form when it is followed by a pronominal suffix. We also — perhaps in error — wave our hands at accents and whether or not a syllable is open or closed. There are some grammatical constructions and rules that are dependent on these factors. For example, without considering if a syllable is open or closed, it is hard to tell if a shewa is vocal or silent. Similarly, an accent on a verb can move when there is a prefixed *waw*. We suspect that the accents can be computed from the phonological rules rather then the other way around. Because of space and time considerations, we choose to work with the fragment of biblical Hebrew conjugation dealing with the "finite" forms of the verb.

Like classical Latin [9], biblical Hebrew is an inflected language. It has 140 finite verb forms, constructed from seven patterns, two tenses and ten persons, while Latin has 90 finite verb forms, constructed from three patterns (*amo*, *amavi*, *amor*), five tenses and six persons. One thing both languages have in common is that not every verb possesses all possible patterns. Thus, Latin *memini* and *nascor* exist only in the second and third pattern respectively; similarly in Hebrew, many verbs fail to possess a full complement of all seven patterns.

We mention two points of difference between Latin and Hebrew. In Latin, each pattern displays a separate conjugation paradigm, whereas in Hebrew, all patterns are conjugated exactly alike, thus making Hebrew computationally easier to manipulate than Latin. On the other hand, Latin pattern 1 determines the semantics of patterns 2 and 3; but in Hebrew, the meanings of the other patterns cannot always be inferred from that of pattern 1. For example, *nikbad*, the alleged passive of *kābad* "to be heavy", can unpredictably mean "to gain honor"[1]. The passive of *pāqad* "to visit" is the seemingly unrelated *nipqad* "to be lacking". (We have here represented each verb by the third person singular of the past tense.)

2 The Hebrew Consonants

To make this paper accessible to readers not familiar with Hebrew, we do not use Hebrew grammatical terminology in the metalanguage, although we sometimes mention the Hebrew word for completeness. We present Hebrew letters in Roman transliteration. Concerning the consonants, we adopt the transliteration system A of the Encyclopedia Judaica (volume VIII page 79):

' b g d h w z ḥ ṭ y k l m n s ' p ṣ q r š ś t

Some sample transliterations are

Aleph	'	Bet	*b*	Dalet	*d*
Ḥet	*ḥ*	Tet	*ṭ*	Kaph	*k*
Samek	*s*	'Ayin	'	Ṣade	*ṣ*
Qoph	*q*	Šin	*š*	Śin	*ś*
		Taw	*t*		

We follow the Gileadites[2] in maintaining the distinctions between the letters *š* and *ś*, which were not distinguished in the original text. Essentially the Hebrew consonants aim to represent what are called "phonemes" in modern linguistics. We will not distinguish between the plosives *b g d p k t* and their spirant (fricative) allophones b^h g^h d^h t^h p^h k^h t^h (denoted by $\underline{b}$, $\underline{g}$, etc in the Encyclopedia). Plosives will automatically appear at the beginning of a word (denoted by # if necessary), after certain prefixes (in which case we place the symbol + between the prefix and the stem), and after another consonant. Otherwise, the letter *b*, *g*, etc. should be read as spirants b^h, g^h etc. In particular, when we have two consecutive consonants, the former is a spirant, if possible, and the latter is a plosive, if possible. A problem may arise when the first consonant has no spirant allophone. However, we will ignore such marginal phenomena.

3 The Masoretic vowels

Apparently, biblical Hebrew contained three basic vowel phenomes[3] a, i and u, like modern standard Arabic. (Note $moslem = muslim$). These were not written originally, although they might be revealed by attached consonants h, y and w respectively[4].

The vowel system now in use goes back to the Tiberian Masoretes[5] (around 800 A.D.), who were closer in time to us than to Ezra (around 600 B.C.), the traditional final editor of the Torah. They claimed to preserve the original pronunciation in all its nuances[6]; but can they really be trusted after such a long time spread?[7] Still, it is difficult to ignore them now. Rather than to question them, we aim to formulate the grammar implied in their system of spelling.

The Masoretes essentially acknowledge seven short and five long [8] vowels:

$$
\begin{array}{ccccccccccccccc}
 & & & a & & & & & & & & \bar{a}(h) & & & \\
 & & \ddot{a} & & \dot{a} & & & & & & ey & & ow & & \\
 & e & & & & o & & & & iy & & & & uw & \\
i & & & & & & u & & & & & & & &
\end{array}
$$

They failed to distinguish between $\bar{a}$ ($q\bar{a}me\d{s} - gadol$) and $\dot{a}$ ($q\bar{a}me\d{s} - katan$). These have indeed complementary distribution, the former occurs only in open syllables and the latter before two consecutive consonants. Both $\ddot{a}$ and $\dot{a}$ might have been allophones of a, although later they became allophones of e and o respectively. In pattern 4, the so called *hoph'al*, there is even a variation between $\dot{a}$ and u.

The Masoretes occasionally also admitted the long vowels $\ddot{a}y$ ($\d{s}ere - yud$) and $\ddot{a}h$ perhaps representing the same sound. In addition, they had a symbol, the shewa, for the so called schwa, a neutral vowel recognized by modern linguists. We shall denote this with a raised $(\quad)^e$. They introduced a very short a, $\ddot{a}$ and $\dot{a}$ ($\d{h}atep - pata\d{h}$, $\d{h}atep - segol$ and $\d{h}atep - q\bar{a}me\d{s}$) which we shall denote by raised ^{a}, $^{\ddot{a}}$ and $^{\dot{a}}$.

The Masoretes also admitted a silent shewa between two consecutive consonants. This we shall omit in our transliteration. Although they used the same symbol for both vocalic and silent schwa, there are standard rules to distinguish them.[9]

4 Vowel transformations

It is not clear to us how exactly the phoneme-allophone distinction may be incorporated into a computational description of Hebrew. What seems important is that a certain symbol (a), is to be pronounced differently in different contexts. In fact we require the following rule:

$$(V) \longrightarrow \begin{cases} \quad V & \text{before } CC' \text{ or } C\# \\ (\quad)^V & \text{before } CV' \\ (\quad)^e & \text{before } C\bar{V}' \end{cases} \tag{4.1}$$

where $V = a$, $\ddot{a}$ or $\dot{a}$. Here C and C' denote consonants, V and V' short vowels, $\bar{V}'$ a long vowel, and # denotes the space between words. The way to read this is that (a) becomes a, $(\quad)^a$ or $(\quad)^e$ depending on what follows, and similarly for $(\ddot{a})$ and $(\dot{a})$. If she wishes, the reader may take (a) to be a phoneme with three allophones.

We shall also postulate

$$(V) \longrightarrow \begin{cases} \quad V & \text{before } CC' \text{ or } C\# \\ (\quad)^e & \text{before } CV' \text{ or } C\bar{V}' \end{cases} \tag{4.2}$$

where $V = e$, i, o or u, except when C or $C' = w$ or y or when $C = C'$. We shall deal with these exceptional cases later.

Unfortunately, (e) must be distinguished from a related symbol $(\acute{e})$ which will turn into a different vowel before two consecutive consonants:

$$(\acute{e}) \longrightarrow \begin{cases} \quad a & \text{before } CC' \\ \quad e & \text{before } C\# \\ (\quad)^e & \text{before } CV' \text{ or } C\bar{V}' \end{cases} \tag{4.3}$$

In order not to make our notation too cumbersome, we shall henceforth drop the parentheses around (a), (e), etc. But this will imply that, before a vowel takes its final form, we will have to look at two or three letters following it (three because a long vowel may be represented by two letters).

5 The Hebrew verb

Most Hebrew verbs are presented by three consonants, called "radicals", and two vowels, which we call "characteristic vowels". This triliteralness[10] is a defining property of all Semitic languages. Three consonants may determine a verb and one forms related words by placing different vowels between these consonants. This is in stark contrast to non-Semitic languages such as English, where the words *boot*, *bait*, *but*, *bat*, *bet*, *boat*, *bit*, etc. have nothing to do with each other.

A verb **V** will be presented as follows:

$$\mathbf{V} = FML\alpha_1, \alpha_2$$

where F, M, and L stand for the First, Middle, and Last radical respectively and α_1 and α_2 are equal to a, $\acute{e}$ or o. The characteristic vowels appear in pattern 1 of the verb only, α_1 in the future and α_2 in the past. For example, Weingreen discusses four verbs, in our notation:

$$q\d{t}loa, \quad q\d{t}nao, \quad kbda\acute{e}, \quad y\d{t}baa$$

(they mean, respectively, "to kill", "to be small", "to be heavy", "to be good"). The third person masculine singular of the future and of the past in pattern 1 is seen as follows

$$\begin{array}{ccc} yiq\d{t}ol & / & q\bar{a}\d{t}al \\ yiq\d{t}an & / & q\bar{a}\d{t}on \\ yikbad & / & k\bar{a}bed \\ yiy\d{t}ab & / & y\bar{a}tab. \end{array}$$

Unfortunately, it must be admitted that different scholars are not necessarily in agreement. Thus Gesenius writes $q^e\d{t}\bar{a}l$ and Halkin [8] writes *kābad*. We prefer Weingreen, who asserts that the vowels *oa* characterize "active" verbs, that is verbs denoting an action, and that *ao*, *aé* and *aa* characterize "stative" verbs, that is verbs denoting a state[11].

The characteristic vowels may be affected by phonological rules. For example, there is an active verb *šlḥaa* "to send" in which the *o* has been replaced by *a*, in view of the fact that *ḥ* is a guttural consonant.

If we look at the first person singular of the past tense of pattern 1, we find that $\acute{e} \longrightarrow a$ in *kbdaé*

$$k\bar{a}b\acute{e}dtiy \longrightarrow k\bar{a}badtiy.$$

This follows from rule (4.3).

In the third person feminine, the characteristic vowel α_2 turns into a schwa and we obtain

$$q\bar{a}\d{t}^e l\bar{a}h, \quad q\bar{a}\d{t}^e n\bar{a}h, \quad k\bar{a}b^e d\bar{a}h, \quad y\bar{a}t^e bn\bar{a}h,$$

from rule (4.1).

6 The Conjugation formula

We distinguish 140 possible finite verb forms $C_{i,j,k}(\mathbf{V})$ for every verb $\mathbf{V}$ where

$$i \quad = \quad 1, \quad 2m, \quad 2f, \quad 3m, \quad 3f, \quad 4, \quad 5m, \quad 5f, \quad 6m, \quad 6f$$

denotes the three persons singular followed by the three persons plural, and m stands for masculine, f for feminine;

$$j \quad = \quad 1, \quad 2$$

denotes the future (also called "imperfect" or "incomplete") tense and the past (also called the "perfect" or "complete") tense respectively;

$$k \quad = \quad 1, \quad 2, \quad \ldots \quad , \quad 7$$

denotes the seven patterns (also called the "forms", "conjugations," or "*binyanim*").

The 140 verb forms are calculated by the formula

$$C_{i,j,k}(\mathbf{V}) \quad \longrightarrow \quad P_{i,j}S_{j,k}(\mathbf{V})Q_{i,j} \tag{6.1}$$

where $P_{i,j}$ and $Q_{i,j}$ are given by the following table.

Table I				
Prefixes and Suffixes				
i	$P_{i,1}$	$Q_{i,1}$	$P_{i,2}$	$Q_{i,2}$
1	'	$\emptyset$	$\emptyset$	tiy
2m	t	$\emptyset$	$\emptyset$	$t\bar{a}$
2f	t	iy	$\emptyset$	t
3m	y	$\emptyset$	$\emptyset$	$\emptyset$
3f	t	$\emptyset$	$\emptyset$	$\bar{a}h$
4	n	$\emptyset$	$\emptyset$	nuw
5m	t	uw	$\emptyset$	$t\ddot{a}m$
5f	t	$n\bar{a}h$	$\emptyset$	$t\ddot{a}n$
6m	y	uw	$\emptyset$	uw
6f	t	$n\bar{a}h$	$\emptyset$	uw

The table encapsulates a number of rewrite rules such as $P_{1,1} \longrightarrow$ ', and $Q_{1,1} \longrightarrow \emptyset$ (the empty string). Note, in particular, that $P_{i,2} \longrightarrow \emptyset$ for all i, hence for $j = 2$ conjugation rule (6.1) may be simplified to

$$C_{i,2,k}(\mathbf{V}) \quad \longrightarrow \quad S_{2,k}(\mathbf{V})Q_{i,2}. \tag{6.2}$$

The seven patterns $S_{j,k}(\mathbf{V})$ are given by the following table:

Table II			
Stem Rewrite Rules			
k	Pattern	Future $S_{1,k}(\mathbf{V})$	Past $S_{2,k}(\mathbf{V})$
1	qal	$iFM\alpha_1 L$	$[F\bar{a}M\alpha_2 L]$
2	niph‘al	$niFF\bar{a}M\acute{e}L$	$niFMaL$
3	hiph‘il	$haFM[ey]L$	$hiFM[ay]L$
4	hoph‘al	$h\dot{a}FMaL$	$h\dot{a}FMaL$
5	pi‘el	$iFaMMeL$	$FiMM\acute{e}L$
6	pu‘al	$iFuMMaL$	$FuMMaL$
7	hitpa‘el	$hit + FaMM\acute{e}L$	$hit + FaMM\acute{e}L$

(Recall from Section 5 that $\mathbf{V} = FML\alpha_1\alpha_2$ and from Section 2 that we place the symbol $+$ between prefix and stem.)

Halkin differs from Weingreen in his treatment of $S_{1,7}(\mathbf{V})$. In our notation, he would put

$$S_{1,7}(\mathbf{V}) \longrightarrow hit + FaMMel,$$

replacing $\acute{e}$ by e.

The patterns[12] usually have the following shades of meaning:

	Pattern			
	Simple	Intensive	Causative	Reflexive
Active	qal $k = 1$	pi'el $k = 5$	hiph'il $k = 3$	hitpa'el $k = 7$
Passive	niph'al $k = 2$	pu'al $k = 6$	hoph'al $k = 4$	

Before embarking on any actual calculations, we must state a number of phonological rewrite rules:

$$h \longrightarrow \begin{cases} \emptyset & \text{after } C \\ h & \text{otherwise} \end{cases} \tag{6.3}$$

$$n \longrightarrow \begin{cases} \emptyset & \text{after } C \\ n & \text{otherwise} \end{cases} \tag{6.4}$$

$$\text{'}i \longrightarrow \begin{cases} \text{'}\ddot{a} & \text{before } CC' \\ \\ {}^{\text{'}a} & \text{before } CV \end{cases} \quad \text{except when } C \text{ or } C' = y \text{ or } w \tag{6.5}$$

When a verb is prefixed with something that ends in a t, the following rule holds[13]

$$t + C \longrightarrow \begin{cases} Ct & \text{if } C = \check{s}, \acute{s} \text{ or } s \\ C\d{t} & \text{if } C = \d{s} \\ CC & \text{if } C = \d{t}, d, z \text{ or } n \text{ (often)} \\ tC & \text{otherwise} \end{cases} \tag{6.6}$$

$$[ey] \longrightarrow \begin{cases} e & \text{after } CC' \\ iy & \text{otherwise} \end{cases} \tag{6.7}$$

$$[ay] \longrightarrow \begin{cases} a & \text{after } CC' \text{ when unstressed} \\ iy & \text{otherwise} \end{cases} \tag{6.8}$$

$$[F\bar{a}MVL] \longrightarrow \begin{cases} F^eM\dot{a}L & \text{when } V = o \text{ before } t\ddot{a}m \text{ or } t\ddot{a}n \\ F^eMVL & \text{when } V = a, \text{ or } \acute{e} \text{ before } t\ddot{a}m \text{ or } t\ddot{a}n \\ F\bar{a}MVL & \text{otherwise} \end{cases} \tag{6.9}$$

(The third case also allows $V = \bar{a}$ in anticipation of Section 10.)

7 Sample calculations for regular verbs

In the following sample calculations, we will show how to calculate $C_{i,j,k}(\mathbf{V})$ when $\mathbf{V}$ is a regular (aka "strong") verb. This means that none of the three radicals is n, w or y, nor a guttural $', h, \d{h}, `$ (and sometimes r). We follow Weingreen and look at the verb $q\d{t}loa$ "to kill"[14] in all seven patterns. Most of our rules will be illustrated by taking $i = 1$ and $6f$. When $j = 2$, we will occasionally also look at $i = 3m$ and $5m$ to illustrate the rôle of rewrite rules replacing $\acute{e}$ by e, $\bar{a}$ by $(\quad)^e$ and o by $\dot{a}$ in certain contexts. The number below the arrow $\longrightarrow_{(\#)}$ is the rule number in this paper. We only supply it when the rule is not obvious.

$$C_{1,1,1}(\mathbf{V}) \longrightarrow P_{1,1}S_{1,1}(\mathbf{V})Q_{1,1} \longrightarrow {}'S_{1,1}(\mathbf{V})Q_{1,1} \longrightarrow {}'iq\d{t}olQ_{1,1}$$
$$\longrightarrow_{(6.5)} {}'\ddot{a}q\d{t}olQ_{1,1} \longrightarrow {}'\ddot{a}q\d{t}ol$$

$$C_{6f,1,1}(\mathbf{V}) \longrightarrow \cdots \longrightarrow tiq\d{t}olQ_{6f,1} \longrightarrow tiq\d{t}oln\bar{a}h$$

$$C_{1,2,1}(\mathbf{V}) \longrightarrow S_{2,1}(\mathbf{V})Q_{1,2} \longrightarrow [q\bar{a}\d{t}al]Q_{1,2} \longrightarrow [q\bar{a}\d{t}al]tiy$$
$$\longrightarrow_{(6.9)} q\bar{a}\d{t}altiy$$

$$C_{5m,2,1}(\mathbf{V}) \longrightarrow \cdots \longrightarrow [q\bar{a}\d{t}al]t\ddot{a}m \longrightarrow_{(6.9)} q^e\d{t}alt\ddot{a}m$$

By contrast, for $\mathbf{V}' = q\d{t}nao$ "to be small", we have

$$C_{5m,2,1}(\mathbf{V}') \longrightarrow \cdots \longrightarrow [q\bar{a}\d{t}on]t\ddot{a}m \longrightarrow_{(6.9)} q^e\d{t}\dot{a}nt\ddot{a}m$$

Returning to $\mathbf{V} = q\d{t}loa$,

$$C_{6f,2,1}(\mathbf{V}) \longrightarrow \cdots \longrightarrow [q\bar{a}\d{t}al]uw \longrightarrow_{(6.9)} q\bar{a}\d{t}aluw \longrightarrow_{(4.1)} q\bar{a}\d{t}^eluw$$

$$C_{1,1,2}(\mathbf{V}) \longrightarrow P_{1,1}S_{1,2}(\mathbf{V})Q_{1,1} \longrightarrow {}'S_{1,2}(\mathbf{V})Q_{1,1} \longrightarrow {}'niqq\bar{a}\d{t}\acute{e}lQ_{1,1} \longrightarrow_{(6.4)} {}'iqq\bar{a}\d{t}\acute{e}lQ_{1,1} \longrightarrow_{(6.5)} {}'\ddot{a}qq\bar{a}\d{t}\acute{e}l \longrightarrow_{(4.3)} {}'\ddot{a}qq\bar{a}\d{t}el$$

$$C_{6f,1,2}(\mathbf{V}) \longrightarrow \cdots \longrightarrow tiqq\bar{a}\d{t}\acute{e}ln\bar{a}h \longrightarrow_{(4.3)} tiqq\bar{a}\d{t}aln\bar{a}h$$

$$C_{1,2,2}(\mathbf{V}) \longrightarrow S_{2,2}(\mathbf{V})Q_{1,2} \longrightarrow niq\d{t}alQ_{1,2} \longrightarrow niq\d{t}altiy$$

$$C_{6f,2,2}(\mathbf{V}) \longrightarrow \cdots \longrightarrow niq\d{t}aluw \longrightarrow_{(4.1)} niq\d{t}^eluw$$

$$C_{1,1,3}(\mathbf{V}) \longrightarrow P_{1,1}S_{1,3}(\mathbf{V})Q_{1,1} \longrightarrow {}'haq\d{t}[ey]lQ_{1,1} \longrightarrow_{(6.3)} {}'aq\d{t}[ey]lQ_{1,1} \longrightarrow {}'aq\d{t}[ey]l \longrightarrow_{(6.7)} {}'aq\d{t}iyl$$

$$C_{6f,1,3}(\mathbf{V}) \longrightarrow \cdots \longrightarrow taq\d{t}[ey]ln\bar{a}h \longrightarrow_{(6.7)} taq\d{t}eln\bar{a}h$$

$$C_{1,2,3}(\mathbf{V}) \longrightarrow S_{2,3}(\mathbf{V})Q_{1,2} \longrightarrow hiq\d{t}[ay]lQ_{1,2} \longrightarrow hiq\d{t}[ay]ltiy \longrightarrow_{(6.8)} hiq\d{t}altiy$$

$$C_{6f,2,3}(\mathbf{V}) \longrightarrow \cdots \longrightarrow hiq\d{t}[ay]luw \longrightarrow_{(6.8)} hiq\d{t}iyluw$$

This example forces us to add the proviso "when unstressed" in case 1 of (6.8), otherwise we would have obtained $hiq\d{t}aluw \longrightarrow hiq\d{t}^eluw$ instead.

$$C_{1,1,4}(\mathbf{V}) \longrightarrow P_{1,1}S_{1,4}(\mathbf{V})Q_{1,1} \longrightarrow {}'S_{1,4}(\mathbf{V})Q_{1,1} \longrightarrow {}'h\dot{a}q\d{t}alQ_{1,1}$$

$\longrightarrow_{(6.3)}$ *'àqṭal*$Q_{1,1} \longrightarrow$ *'àqṭal*

$C_{6f,1,4}(\mathbf{V}) \longrightarrow \cdots \longrightarrow$ *tàqtal*$Q_{6f,1} \longrightarrow$ *tàqṭalnāh*

$C_{1,2,4}(\mathbf{V}) \longrightarrow S_{2,4}(\mathbf{V})Q_{1,2} \longrightarrow$ *hàqṭal*$Q_{1,2} \longrightarrow$ *hàqṭaltiy*

$C_{6f,2,4}(\mathbf{V}) \longrightarrow \cdots \longrightarrow$ *hàqṭaluw* $\longrightarrow_{(4.1)}$ *hàqṭ*^{e}*luw*

$C_{1,1,5}(\mathbf{V}) \longrightarrow P_{1,1}S_{1,5}(\mathbf{V})Q_{1,1} \longrightarrow$ *'*$S_{1,5}(\mathbf{V})Q_{1,1} \longrightarrow$ *'iqaṭṭel*$Q_{1,1}$
$\longrightarrow_{(6.5)}$ *'*^{a}*qaṭṭel*$Q_{1,1} \longrightarrow$ *'*^{a}*qaṭṭel*

$C_{1,2,5}(\mathbf{V}) \longrightarrow S_{2,5}(\mathbf{V})Q_{1,2} \longrightarrow$ *qiṭṭél*$Q_{1,2} \longrightarrow$ *qiṭṭéltiy* $\longrightarrow_{(4.3)}$ *qiṭṭaltiy*

$C_{3m,2,5}(\mathbf{V}) \longrightarrow \cdots \longrightarrow$ *qiṭṭél* $\longrightarrow_{(4.3)}$ *qiṭṭel*

$C_{6f,2,5}(\mathbf{V}) \longrightarrow \cdots \longrightarrow$ *qiṭṭéluw* $\longrightarrow_{(4.3)}$ *qiṭṭ*^{e}*luw*

$C_{1,1,6}(\mathbf{V}) \longrightarrow P_{1,1}S_{1,6}(\mathbf{V})Q_{1,1} \longrightarrow$ *'*$S_{1,6}(\mathbf{V})Q_{1,1} \longrightarrow$ *'iquṭṭal*$Q_{1,1}$
$\longrightarrow_{(6.5)}$ *'*^{a}*quṭṭal*$Q_{1,1} \longrightarrow$ *'*^{a}*quṭṭal*

$C_{6f,1,6}(\mathbf{V}) \longrightarrow \cdots \longrightarrow$ *tiquṭṭal*$Q_{6f,1} \longrightarrow_{(4.2)}$ *t*^{e}*quṭṭal*$Q_{6f,1} \longrightarrow$ *t*^{e}*quṭṭalnāh*

$C_{1,2,6}(\mathbf{V}) \longrightarrow \cdots \longrightarrow S_{2,6}(\mathbf{V})Q_{1,2} \longrightarrow$ *quṭṭal*$Q_{1,2} \longrightarrow$ *quṭṭaltiy*

$C_{6f,2,6}(\mathbf{V}) \longrightarrow \cdots \longrightarrow$ *quṭṭaluw* $\longrightarrow_{(4.1)}$ *quṭṭ*^{e}*luw*

$C_{1,1,7}(\mathbf{V}) \longrightarrow P_{1,1}S_{1,7}(\mathbf{V})Q_{1,1} \longrightarrow \cdots \longrightarrow$ *'hit* $+$ *qaṭṭél*$Q_{1,1}$
$\longrightarrow_{(6.3)}$ *'it* $+$ *qaṭṭél*$Q_{1,1} \longrightarrow_{(6.6)}$ *'itqaṭṭél*$Q_{1,1} \longrightarrow_{(6.5)}$ *'ätqaṭṭél*$Q_{1,1}$
$\longrightarrow$ *'ätqaṭṭél* $\longrightarrow_{(4.3)}$ *'ätqaṭṭel*

$C_{6f,1,7}(\mathbf{V}) \longrightarrow \cdots \longrightarrow titqa\d{t}\d{t}\acute{e}ln\bar{a}h \longrightarrow_{(4.3)} titqa\d{t}\d{t}aln\bar{a}h$

$C_{1,2,7}(\mathbf{V}) \longrightarrow \cdots \longrightarrow hit + qa\d{t}\d{t}\acute{e}lQ_{1,2} \longrightarrow_{(6.6)} hitqa\d{t}\d{t}\acute{e}lQ_{1,2}$
$\longrightarrow hitqa\d{t}\d{t}\acute{e}ltiy \longrightarrow_{(4.3)} hitqa\d{t}\d{t}altiy$

$C_{6f,2,7}(\mathbf{V}) \longrightarrow \cdots \longrightarrow hitqa\d{t}\d{t}\acute{e}luw \longrightarrow_{(4.3)} hitqa\d{t}\d{t}^{e}luw$

8 Quadriliterals

While most verbs have exactly three consonants, there are some with four. Weingreen mentions only one such verb explicitly, namely *krṣṣ*; but implicitly he allows that others appear in late Biblical Hebrew such as *qwwm* and *mwtt*, in certain patterns of otherwise triliteral verbs. In modern Hebrew, as in modern standard Arabic, quadriliterals proliferate (see Halkin [8]). Both Hebrew and Arabic apply the same trick to derive the conjugation of quadriliterals from triliterals. Noting that in patterns 5,6 and 7 of regular verbs the medial consonant is doubled, all one has to do is to replace MM by M_1M_2, where $M_1 \neq M_2$. It follows that quadriliterals can exist only in patterns 5,6 and 7.

For example, here is how we can calculate pattern 5 of $\mathbf{V} = krsm$ "to gnaw". (There is no need for characteristic vowels, which appear only in pattern 1.)

$C_{1,1,5}(\mathbf{V}) \longrightarrow P_{1,1}S_{1,5}(\mathbf{V})Q_{1,1} \longrightarrow {}'S_{1,5}(\mathbf{V})Q_{1,1} \longrightarrow {}'ikarsemQ_{1,1}$
$\longrightarrow_{(6.5)} {}'^{a}karsemQ_{1,1} \longrightarrow {}'^{a}karsem$

$C_{6f,1,5}(\mathbf{V}) \longrightarrow \cdots \longrightarrow tikarsemQ_{6f,1} \longrightarrow_{(4.2)} t^{e}karsemQ_{6f,1} \longrightarrow t^{e}karsemn\bar{a}h$

$C_{1,2,5}(\mathbf{V}) \longrightarrow \cdots \longrightarrow kirs\acute{e}mQ_{1,2} \longrightarrow kirs\acute{e}mtiy \longrightarrow_{(4.3)} kirsamtiy$

$C_{3m,2,5}(\mathbf{V}) \longrightarrow \cdots \longrightarrow kirs\acute{e}m \longrightarrow_{(4.3)} kirsem$

$C_{6f,2,5}(\mathbf{V}) \longrightarrow \cdots \longrightarrow kirs\acute{e}muw \longrightarrow_{(4.3)} kirs^{e}muw$

This verb is found in the Bible with a pronominal suffix: $y^e kars^e männāh$ "he (a boar) doth ravage it (a vine)" (Psalms 80:14). We shall not analyze pronominal suffixes here.

Several other quadraliteral verbs found in the Bible are

- *ruṭ*^{a}*paš* "To grow fresh again" (Job 33:25). Chomsky [6] on page 216 footnote 349, mentions a source which explains the hatef-pataḥ under the *ṭ* due to euphonic difficulties in the transition from *ṭ* to *p*. There are many who say that the word is not a quadriliteral but is in fact a portmanteau word combined of two other words. (See the commentaries *ad loc.* and on the Babylonian Talmud Nedarim 41a.) There are still others who think that the r is a dittographic from the previous word.
- $m^e kurb\bar{a}l$ "to clothe" (I Chronicals 15:27) which is similar to the passive particle (hence the m^e) of the pual.
- *paršez* "to spread" (Job 26:9). Some authors say that this is an infinitive absolute of the piel pattern.

There are no five-letter verbs in Biblical Hebrew. In contrast, there are many in modern Hebrew. There are numerous quadriliterals and five-letter nouns in Biblical Hebrew.[15]

9 Weak Verbs and Weak Verbs with $F = n$

Triliteral verbs are said to be "weak" if they contain the gutturals $', h, ḥ, '$ and sometimes r, the assimilable n or the semi-consonants y or w. As Weingreen puts it: "weak verbs [...] are explained rationally by the simple method of applying to these verbs the ordinary rules governing 'peculiar' letters and working out the forms which they, respectively, assume." In other words, weak verbs are conjugated like regular ones and then transformed with the help of appropriate phonological rules. In principle, these rules are not restricted to verbal contexts, but these are the only contexts we have looked at here. How this program is carried out in detail will occupy most of the remaining sections of this paper.

Special considerations must also be given to verbs where two contiguous radicals coincide. We will look at this in Section 15.

In the present section we consider the case $F = n$. When the letter n occurs as the first radical of a verb, and sometimes elsewhere, it may be assimilated to the following consonant. We will write (n) for the assimilable n, to distinguish it from the usual letter n. It obeys the following rule:

$$V(n)C \longrightarrow \begin{cases} VnC & \text{if } C \text{ is a gutteral} \\ Vnn & \text{if } C = (n) \\ VCC & \text{otherwise} \end{cases} \tag{9.1}$$

$$(n) \longrightarrow n \text{ before a vowel or } \# \tag{9.2}$$

We also note that, in unstressed syllables,

$$VCC \longrightarrow uCC \text{ if } V = o \text{ or } \dot{a} \tag{9.3}$$

The restriction to unstressed syllables is necessary in view of *qāṭonnuw* and *tiqṭonnāh*.

We will now calculate some representative finite forms of the verb $\mathbf{V} = (n)ploa$ "to fall".

$C_{1,1,1}(\mathbf{V}) \longrightarrow P_{1,1}S_{1,1}(\mathbf{V})Q_{1,1} \longrightarrow {}'S_{1,1}(\mathbf{V})Q_{1,1} \longrightarrow {}'i(n)polQ_{1,1}$
$\longrightarrow_{(6.5)} {}'\ddot{a}(n)polQ_{1,1} \longrightarrow_{(9.1)} {}'\ddot{a}ppolQ_{1,1} \longrightarrow {}'\ddot{a}ppol$

$C_{6f,1,1}(\mathbf{V}) \longrightarrow \cdots \longrightarrow tippoln\bar{a}h$

$C_{1,2,1}(\mathbf{V}) \longrightarrow S_{1,2}(\mathbf{V})Q_{1,2} \longrightarrow [(n)\bar{a}pal]Q_{1,2} \longrightarrow_{(9.2)} [n\bar{a}pal]Q_{1,2}$
$\longrightarrow [n\bar{a}pal]tiy \longrightarrow_{(6.9)} n\bar{a}paltiy$

$C_{5m,2,1}(\mathbf{V}) \longrightarrow \cdots \longrightarrow [n\bar{a}pal]t\ddot{a}m \longrightarrow_{(6.9)} n^e palt\ddot{a}m$

$C_{6f,2,1}(\mathbf{V}) \longrightarrow \cdots \longrightarrow n\bar{a}paluw \longrightarrow_{(4.1)} n\bar{a}p^e luw$

$C_{1,1,2}(\mathbf{V}) \longrightarrow P_{1,1}S_{1,2}(\mathbf{V})Q_{1,1} \longrightarrow {}'S_{1,2}(\mathbf{V})Q_{1,1} \longrightarrow {}'i(n)(n)\bar{a}p\acute{e}lQ_{1,1}$
$\longrightarrow_{(6.5)} {}'\ddot{a}(n)(n)\bar{a}p\acute{e}lQ_{1,1} \longrightarrow_{(9.1)} {}'\ddot{a}nnap\acute{e}lQ_{1,1} \longrightarrow {}'\ddot{a}nnap\acute{e}l \longrightarrow_{(4.3)} {}'\ddot{a}nnapel$

$$C_{6f,1,2}(\mathbf{V}) \longrightarrow \cdots \longrightarrow tinn\bar{a}p\acute{e}ln\bar{a}h \longrightarrow_{(4.3)} tinn\bar{a}paln\bar{a}h$$

$$C_{1,2,2}(\mathbf{V}) \longrightarrow S_{2,2}(\mathbf{V})Q_{1,2} \longrightarrow ni(n)palQ_{1,2} \longrightarrow_{(9.1)} nippalQ_{1,2} \longrightarrow nippaltiy$$

$$C_{1,1,3}(\mathbf{V}) \longrightarrow P_{1,1}S_{1,3}(\mathbf{V})Q_{1,1} \longrightarrow {}'S_{1,3}(\mathbf{V})Q_{1,1} \longrightarrow {}'ha(n)p[ey]lQ_{1,1}$$
$$\longrightarrow_{(6.3)} {}'a(n)p[ey]lQ_{1,1} \longrightarrow_{(9.1)} {}'app[ey]lQ_{1,1} \longrightarrow {}'app[ey]l \longrightarrow_{(6.7)} {}'appiyl$$

$$C_{1,2,3}(\mathbf{V}) \longrightarrow S_{2,3}(\mathbf{V})Q_{1,2} \longrightarrow hi(n)p[ay]lQ_{1,2} \longrightarrow_{(9.1)} hipp[ay]lQ_{1,2}$$
$$\longrightarrow hipp[ay]ltiy \longrightarrow_{(6.8)} hippaltiy$$

$$C_{1,1,4}(\mathbf{V}) \longrightarrow P_{1,1}S_{1,4}(\mathbf{V})Q_{1,1} \longrightarrow {}'S_{1,4}(\mathbf{V})Q_{1,1} \longrightarrow {}'h\dot{a}(n)palQ_{1,1}$$
$$\longrightarrow_{(6.3)} {}'\dot{a}(n)palQ_{1,1} \longrightarrow_{(9.1)} {}'\dot{a}ppalQ_{1,1} \longrightarrow_{(9.3)} {}'uppalQ_{1,1} \longrightarrow {}'uppal$$

$$C_{1,2,4}(\mathbf{V}) \longrightarrow S_{2,4}(\mathbf{V})Q_{1,2} \longrightarrow h\dot{a}(n)palQ_{1,2} \longrightarrow_{(9.1)} h\dot{a}ppalQ_{1,2}$$
$$\longrightarrow_{(9.3)} huppalQ_{1,2} \longrightarrow huppaltiy$$

Weingreen lists no other pattern for this verb, but Halkin considers pattern 7 (*hitpa'el*) which contains no surprises. But recall that he has e in place of $\acute{e}$ in table II, and so he obtains

$$C_{6f,1,7}(\mathbf{V}) \longrightarrow tit + (n)appelQ_{6f,1} \longrightarrow_{(6.6)} tit(n)appelQ_{6f,1}$$
$$\longrightarrow_{(9.2)} titnappelQ_{6f,1} \longrightarrow titnappeln\bar{a}h$$

where we would expect $titnappaln\bar{a}h$.

There is one verb in which the letter l is similarly assimilable, *lqḥaa* "to take". Note that $\alpha_1 = a$ rather than o since $\d{h}$ is a guttural.

There is one common verb in which both the first and the last radical is an assimilable n, the verb $(n)t(n)\acute{e}a$ "to give". This is an example of a doubly weak verb about which we shall see more of in Section 16. For some reason, $\alpha_1 = \acute{e}$ rather then o. At the beginning, this verb is treated like $(n)ploa$, so we only have to look at the end of the calculations.

$$C_{1,1,1}(\mathbf{V}) \longrightarrow \cdots \longrightarrow {}'\ddot{a}tte(n) \longrightarrow_{(9.2)} {}'\ddot{a}tten$$

$$C_{6f,1,1}(\mathbf{V}) \longrightarrow \cdots \longrightarrow titt\acute{e}(n)n\bar{a}h \longrightarrow_{(9.1)} titt\acute{e}nn\bar{a}h \longrightarrow_{(4.3)} tittann\bar{a}h$$

$$C_{1,2,1}(\mathbf{V}) \longrightarrow \cdots \longrightarrow n\bar{a}ta(n)tiy \longrightarrow_{(9.1)} n\bar{a}tattiy$$

$$C_{3m,2,1}(\mathbf{V}) \longrightarrow \cdots \longrightarrow n\bar{a}ta(n) \longrightarrow_{(9.2)} n\bar{a}tan$$

$$C_{6f,1,2}(\mathbf{V}) \longrightarrow \cdots \longrightarrow {}'\ddot{a}nnat\acute{e}(n) \longrightarrow_{(9.2)} {}'\ddot{a}nnat\acute{e}n \longrightarrow_{(4.3)} {}'\ddot{a}nnaten$$

$$C_{3m,2,2}(\mathbf{V}) \longrightarrow \cdots \longrightarrow nitta(n)tiy \longrightarrow_{(9.1)} nittattiy$$

10 Weak verbs with guttural radicals

The gutturals (also called "laryngals") in Hebrew are $', h, \d{h}, `$. Here ' and ‘ can be subclassified as weak gutturals in contrast to h and $\d{h}$ which are called strong gutturals. Because there is latitude about the level of "gutturalness", there is latitude about the extent that each letter follows the guttural rules.

Although r is technically not a guttural, it still follows several guttural rules.

In Hebrew a guttural can not be doubled [16] (i.e., accept a dagesh). Rather than extending the guttural, we lengthen the vowel before the guttural:

$$iGG \longrightarrow eG \tag{10.1}$$

$$uGG \longrightarrow oG \tag{10.2}$$

$$aGG \longrightarrow \bar{a}G \tag{10.3}$$

(Note that the vowel before a doubled consonant other then n is always a, i or u in unstressed syllables.)

Gutturals cannot even be immediately followed by another consonant. Thus, we have (except for $G = r$)

$$VGC \longrightarrow VGVC \text{ when } V = \ddot{a}, a, \dot{a}, \tag{10.4}$$

assuming that $C \neq G$. Recalling that, for such V, $V \longrightarrow (\quad)^V$, by (4.1) we infer that

$$VGC \longrightarrow VG^VC \tag{10.5}$$

before a short vowel V'.

There is also a rule introducing a so-called *furtive a* at the end of a verb form:

$$\bar{V}G \longrightarrow \bar{V}aG \text{ before } \#, \text{ when } \bar{V} \text{ is any long vowel.} \tag{10.6}$$

Furthermore, there is a rule which transforms the vowel i before a preliminary guttural-consonant combination:

$$iGC \longrightarrow \begin{cases} \ddot{a}GC & \text{after ' or } h \text{ or in pattern 1 of stative verbs} \\ aGC & \text{otherwise,} \end{cases} \tag{10.7}$$

assuming that $C \neq G$.

It follows from (10.7) and (10.4) that

$$iGC \longrightarrow \ddot{a}G^{\ddot{a}}C \text{ or } aG^aC \text{ before } V' \tag{10.8}$$

in the two cases respectively.

Which gutturals may occur in different places of a triliteral verb? One considers the following cases:

$$F \quad = \quad G \quad = \quad \text{'}, h, \d{h} \text{ or ‘},$$

with exceptions when ’ is quiescent or when $\d{h}$ is harsh.

$$M \quad = \quad G \quad = \quad \text{'}, h, \d{h}, \text{‘}, r,$$

where r is perhaps pronounced as in Parisian French (see sec. 22q,r of [7]).

$$L \quad = \quad G \quad = \quad \text{‘ or } \d{h}$$

$L =$ ’ is quiescent and $L = h$ really stands for $L = y$ or $L = w$, as we shall see in Section 14 below.

The letter $\d{h}$ is harsh in some exceptional verbs and can be followed by a consonant after all, as in the future *yäḥšak* “he will be dark” of the stative verb *ḥškaé* "to be dark" or the future *yaḥmod* "he will be desired" of the active verb *ḥmdoa*"to be desired".

The letter ' is always quiescent before # or constants, that is, it does not count as a consonant when applying rule (4.1). We postulate:

$$a\text{'} \longrightarrow \begin{cases} \bar{a}\text{'} & \text{before } \# \text{ or }] \\ e\text{'} & \text{before } C \neq h \end{cases} \tag{10.9}$$

$$\bar{a}\text{'}, e\text{'}, \acute{e}\text{'} \longrightarrow \ddot{a}\text{'} \text{ before } n\bar{a}h \tag{10.10}$$

Here are some sample calculations. First consider $F = G$, e.g. for $\mathbf{V} =$ *'mdoa* "to stand".

$$C_{1,1,1}(\mathbf{V}) \longrightarrow P_{1,1}S_{1,1}(\mathbf{V})Q_{1,1} \longrightarrow \text{'}S_{1,1}(\mathbf{V})Q_{1,1} \longrightarrow \text{'}i\text{'}modQ_{1,1}$$
$$\longrightarrow_{(10.7)} \text{'}\ddot{a}\text{'}modQ_{1,1} \longrightarrow_{(10.5)} \text{'}\ddot{a}\text{'}^{\ddot{a}}modQ_{1,1} \longrightarrow \text{'}\ddot{a}\text{'}^{\ddot{a}}mod$$

$$C_{6f,1,1}(\mathbf{V}) \longrightarrow \cdots \longrightarrow ta\text{'}modQ_{6f,1} \longrightarrow_{(10.5)} ta\text{'}^{a}modQ_{6f,1} \longrightarrow ta\text{'}^{a}modn\bar{a}h$$

$$C_{1,1,2}(\mathbf{V}) \longrightarrow P_{1,1}S_{1,2}(\mathbf{V})Q_{1,1} \longrightarrow \text{'}S_{1,2}(\mathbf{V})Q_{1,1} \longrightarrow \text{'}ni\text{''}\bar{a}m\acute{e}dQ_{1,1}$$
$$\longrightarrow_{(6.4)} \text{'}i\text{''}\bar{a}m\acute{e}dQ_{1,1} \longrightarrow_{(10.1)} \text{'}e\text{'}\bar{a}m\acute{e}dQ_{1,1} \longrightarrow \text{'}e\text{'}\bar{a}m\acute{e}d \longrightarrow_{(4.3)} \text{'}e\text{'}\bar{a}med$$

$$C_{3m,2,3}(\mathbf{V}) \longrightarrow P_{3m,2}S_{2,3}(\mathbf{V})Q_{3m,2} \longrightarrow hi\text{'}m[ay]dQ_{3m,2} \longrightarrow_{(10.8)} h\ddot{a}\text{'}^{\ddot{a}}m[ay]dQ_{3m,2}$$
$$\longrightarrow h\ddot{a}\text{'}^{\ddot{a}}m[ay]d \longrightarrow_{(6.8)} h\ddot{a}\text{'}^{\ddot{a}}miyd$$

As an example of a weak verb with $M = G$, take $\mathbf{V} =$ *brkaa* "to bless",

$$C_{1,1,5}(\mathbf{V}) \longrightarrow P_{1,1}S_{1,5}(\mathbf{V})Q_{1,1} \longrightarrow \text{'}ibarrekQ_{1,1} \longrightarrow_{(6.5)} \text{'}^{a}barrekQ_{1,1}$$
$$\longrightarrow_{(10.3)} \text{'}^{a}b\bar{a}rekQ_{1,1} \longrightarrow \text{'}^{a}b\bar{a}rek$$

$$C_{1,2,5}(\mathbf{V}) \longrightarrow S_{2,5}(\mathbf{V})Q_{1,2} \longrightarrow birr\acute{e}kQ_{1,2} \longrightarrow_{(10.1)} ber\acute{e}kQ_{1,2}$$
$$\longrightarrow ber\acute{e}ktiy \longrightarrow_{(4.3)} beraktiy$$

$$C_{1,1,6}(\mathbf{V}) \longrightarrow \cdots \longrightarrow \text{'}iburrakQ_{1,1} \longrightarrow_{(6.5)} \text{'}^{a}burrakQ_{1,1}$$
$$\longrightarrow_{(10.2)} \text{'}^{a}borakQ_{1,1} \longrightarrow \text{'}^{a}borak$$

As an example of a weak verb with $L = G$, take $\mathbf{V} = \check{s}l\d{h}aa$ "to send".

$C_{1,1,3}(\mathbf{V}) \longrightarrow \cdots \longrightarrow \text{'}ha\check{s}l[ey]\d{h}Q_{1,1} \longrightarrow_{(6.3)} \text{'}a\check{s}l[ey]\d{h}Q_{1,1} \longrightarrow \text{'}a\check{s}l[ey]\d{h} \longrightarrow_{(6.7)} \text{'}a\check{s}liy\d{h} \longrightarrow_{(10.6)} \text{'}a\check{s}liya\d{h}$

$C_{3m,2,3}(\mathbf{V}) \longrightarrow \cdots \longrightarrow hi\check{s}liy\d{h} \longrightarrow_{(10.6)} hi\check{s}liya\d{h}$

As an example of a weak verb in which L is a quiescent ', take $\mathbf{V} = m\d{s}\text{'}aa$ "to find".

$C_{1,1,1}(\mathbf{V}) \longrightarrow \cdots \longrightarrow \text{'}\ddot{a}m\d{s}a\text{'} \longrightarrow_{(10.9)} \text{'}\ddot{a}m\d{s}\bar{a}\text{'}$

$C_{6f,1,1}(\mathbf{V}) \longrightarrow \cdots \longrightarrow tim\d{s}a\text{'}n\bar{a}h \longrightarrow_{(10.10)} tim\d{s}\ddot{a}\text{'}n\bar{a}h$

$C_{1,2,1}(\mathbf{V}) \longrightarrow \cdots \longrightarrow [m\bar{a}\d{s}a\text{'}]tiy \longrightarrow_{(10.9)} [m\bar{a}\d{s}\bar{a}\text{'}]tiy \longrightarrow_{(6.9)} m\bar{a}\d{s}\bar{a}\text{'}tiy$

$C_{1,1,2}(\mathbf{V}) \longrightarrow \cdots \longrightarrow \text{'}\ddot{a}mm\bar{a}\d{s}\acute{e}\text{'} \longrightarrow_{(4.3)} \text{'}\ddot{a}mm\bar{a}\d{s}e\text{'}$

$C_{1,1,2}(\mathbf{V}) \longrightarrow \cdots \longrightarrow nim\d{s}a\text{'}tiy \longrightarrow_{(10.9)} nim\d{s}e\text{'}tiy$

$C_{6f,1,3}(\mathbf{V}) \longrightarrow \cdots \longrightarrow tam\d{s}e\text{'}n\bar{a}h \longrightarrow_{(10.10)} tam\d{s}\ddot{a}\text{'}n\bar{a}h$

In five exceptional verbs *'bdaā* "to perish" (or "to lose"), *'bhaa* "to be willing", *'klaa* "to eat", *'mraa* "to say" and *'phaa* "to bake" $F =$ ' is quiescent. This affects the conjugational form but only for $j = 1$ (future) and $k = 1$ (qal).

$$i\text{'}C \longrightarrow \begin{cases} oC & \text{after '} \\ o\text{'}C & \text{otherwise} \end{cases} \tag{10.11}$$

Here are some sample calculations for $\mathbf{V} = \text{'}klaa$,

$C_{1,1,1}(\text{'}klaa) \longrightarrow P_{1,1}S_{1,1}(\text{'}klaa)Q_{1,1} \longrightarrow \text{'}iS_{1,1}(\text{'}klaa)Q_{1,1} \longrightarrow \text{'}i\text{'}kalQ_{1,1} \longrightarrow_{(10.11)} \text{'}okalQ_{1,1} \longrightarrow \text{'}okal$

$C_{3f,1,1}(\text{'}klaa) \longrightarrow P_{3f,1}S_{1,1}(\text{'}klaa)Q_{3f,1} \longrightarrow tS_{1,1}(\text{'}klaa)Q_{3f,1} \longrightarrow ti\text{'}kalQ_{3f,1}$

$\longrightarrow_{(10.11)}$ $to\text{'}kalQ_{3f,1} \longrightarrow to\text{'}kal$

$C_{6m,1,1}(\text{'}klaa) \longrightarrow P_{6m,1}S_{1,1}(\text{'}klaa)Q_{6m,1} \longrightarrow yS_{1,1}(\text{'}klaa)Q_{6m,1} \longrightarrow yi\text{'}kalQ_{6m,1}$
$\longrightarrow_{(10.11)} yo\text{'}kalQ_{6m,1} \longrightarrow yo\text{'}kaluw \longrightarrow_{(4.1)} yo\text{'}k^{e}luw.$

For $j \neq 1$ or $k \neq 1$, the regular conjugations will work. The other verbs with $F =$ ' quiescent are treated similarly, except that the two with $L = h$ (or rather $L = y$ in line with Section 14) are doubly weak and fall under Section 16.

When one of the root letters is a guttural, the changes to the stem rewrite rules can be seen by looking at the guttural rules. Not every case requires a change. We have summarized which rewrites change in the following table. The table is split into two parts depending on which of the first two root letters is a guttural.

Table IIa		
Stem Rewrite Rules For Guttural Verbs		
k	Future $S_{1,k}(\mathbf{V})$	Past $S_{2,k}(\mathbf{V})$
F=G		
1	$iGM\alpha_1L$	$[G\bar{a}M\alpha_2L]$
2	$niGG\bar{a}M\acute{e}L \longrightarrow_{(10.1)} neG\bar{a}M\acute{e}L$	$niGMaL$
3	$haGM[ey]L \longrightarrow_{(10.4)} haGaM[ey]L$	$hiGM[ay]L$
4	$h\dot{a}GMaL \longrightarrow_{(10.4)} h\dot{a}G\dot{a}MaL$	$h\dot{a}GMaL \longrightarrow_{(10.4)} h\dot{a}G\dot{a}MaL$
5	$iGaMMeL$	$GiMM\acute{e}L$
6	$iGuMMaL$	$GuMMaL$
7	$hit + GaMM\acute{e}L$	$hit + GaMM\acute{e}L$
M=G		
1	$iFG\alpha_1L$	$[F\bar{a}G\alpha_2L]$
2	$niFF\bar{a}G\acute{e}L$	$niFGaL$
3	$haFG[ey]L$	$hiFG[ay]L$
4	$h\dot{a}FGaL$	$h\dot{a}FGaL$
5	$iFaGGeL \longrightarrow_{(10.3)} iF\bar{a}GeL$	$FiGG\acute{e}L \longrightarrow_{(10.1)} FeG\acute{e}L$
6	$iFuGGaL \longrightarrow_{(10.2)} iFoGaL$	$FuGGaL \longrightarrow_{(10.2)} FoGaL$
7	$hit + FaGG\acute{e}L \longrightarrow_{(10.3)} hit + F\bar{a}G\acute{e}L$	$hit + FaGG\acute{e}L \longrightarrow_{(10.3)} hit + F\bar{a}G\acute{e}L$

The only changes when $L = G$ depend on and must take account of the suffixes and cannot be summarized in our table.

11 Weak verbs with $F = y$ or w

According to Weingreen, there are two types of verbs with $F = y$ or $F = w$. The former occurs in the stative verb *yṭbaa*"to be good" and requires the following phonological rules:

$$ay \longrightarrow ey \tag{11.1}$$

$$hiy \longrightarrow hey \tag{11.2}$$

Note that *'iy* does not change.

$F = w$ occurs only in patterns 2,3 and 4. It is replaced by $F = y$ in patterns 5,6 and 7 (not discussed by Weingreen) and by $F = (y)$ in pattern 1, where (y) is a potential y. An example is the verb *(y)šbéa/wšb/yšb*. We require the following phonological rules:

$$iw \longrightarrow ow \qquad \text{except before } w \tag{11.3}$$

$$aw \longrightarrow ow \qquad \text{except before } w \tag{11.4}$$

$$\dot{a}w \longrightarrow uw \tag{11.5}$$

$$i(y) \longrightarrow e \tag{11.6}$$

$$\#(y) \longrightarrow \#y. \tag{11.7}$$

Here are some sample calculations for $\mathbf{V} = y\d{t}baa$:

$$C_{1,1,1}(\mathbf{V}) \longrightarrow P_{1,1}S_{1,1}(\mathbf{V})Q_{1,1} \longrightarrow {}'S_{1,1}(\mathbf{V})Q_{1,1} \longrightarrow {}'iy\d{t}abQ_{1,1} \longrightarrow {}'iy\d{t}ab$$

$$C_{1,1,3}(\mathbf{V}) \longrightarrow P_{1,1}S_{1,3}(\mathbf{V})Q_{1,1} \longrightarrow {}'S_{1,3}(\mathbf{V})Q_{1,1} \longrightarrow {}'hay\d{t}[ey]bQ_{1,1}$$
$$\longrightarrow_{(6.3)} {}'ay\d{t}[ey]bQ_{1,1} \longrightarrow_{(11.1)} {}'ey\d{t}[ey]bQ_{1,1} \longrightarrow {}'ey\d{t}[ey]b \longrightarrow_{(6.7)} {}'ey\d{t}iyb$$

$$C_{6f,1,3}(\mathbf{V}) \longrightarrow \cdots \longrightarrow tay\d{t}[ey]bQ_{6f,1} \longrightarrow_{(11.1)} tey\d{t}[ey]bQ_{6f,1}$$
$$\longrightarrow tey\d{t}[ey]bn\bar{a}h \longrightarrow_{(6.7)} tey\d{t}ebn\bar{a}h$$

Actually, Weingreen lists *teyṭabnāh* on page 268, but we cannot reconcile this with our rules. However, Gesenius on page 523 agrees with us. The following calculations are for the verb $\mathbf{V} = (y)\check{s}b\acute{e}a/w\check{s}b/y\check{s}b$ "to sit" for patterns 1 / 2,3,4 / 5,6,7 respectively.

$$C_{1,1,1}(\mathbf{V}) \longrightarrow P_{1,1}S_{1,1}(\mathbf{V})Q_{1,1} \longrightarrow {}'S_{1,1}(\mathbf{V})Q_{1,1} \longrightarrow {}'i(y)\check{s}\acute{e}bQ_{1,1} \longrightarrow_{(11.6)} {}'e\check{s}\acute{e}bQ_{1,1} \longrightarrow {}'e\check{s}\acute{e}b \longrightarrow_{(4.3)} {}'e\check{s}eb$$

$$C_{6f,1,1}(\mathbf{V}) \longrightarrow \cdots \longrightarrow te\check{s}\acute{e}bQ_{6f,1} \longrightarrow te\check{s}\acute{e}bn\bar{a}h \longrightarrow_{(4.3)} te\check{s}abn\bar{a}h$$

$$C_{1,1,2}(\mathbf{V}) \longrightarrow P_{1,1}S_{1,2}(\mathbf{V})Q_{1,1} \longrightarrow {}'S_{1,2}(\mathbf{V})Q_{1,1} \longrightarrow {}'niww\bar{a}\check{s}\acute{e}b \longrightarrow_{(6.4)} {}'iww\bar{a}\check{s}\acute{e}b \longrightarrow_{(4.3)} {}'iww\bar{a}\check{s}eb$$

$$C_{1,2,2}(\mathbf{V}) \longrightarrow S_{2,2}(\mathbf{V})Q_{1,2} \longrightarrow niw\check{s}abQ_{1,2} \longrightarrow_{(11.3)} now\check{s}abQ_{1,2} \longrightarrow now\check{s}abtiy$$

$$C_{1,1,3}(\mathbf{V}) \longrightarrow \cdots \longrightarrow {}'aw\check{s}[ey]bQ_{1,1} \longrightarrow_{(11.4)} {}'ow\check{s}[ey]bQ_{1,1} \longrightarrow {}'ow\check{s}[ey]b \longrightarrow {}'ow\check{s}iyb$$

$$C_{1,2,3}(\mathbf{V}) \longrightarrow \cdots \longrightarrow hiw\check{s}[ay]bQ_{1,2} \longrightarrow_{(11.3)} how\check{s}[ay]bQ_{1,2} \longrightarrow how\check{s}[ay]btiy \longrightarrow_{(6.8)} how\check{s}abtiy$$

$$C_{1,2,4}(\mathbf{V}) \longrightarrow S_{2,4}(\mathbf{V})Q_{1,2} \longrightarrow h\dot{a}w\check{s}abQ_{1,2} \longrightarrow_{(11.5)} huw\check{s}abQ_{1,2} \longrightarrow huw\check{s}abtiy$$

$$C_{1,1,5}(\mathbf{V}) \longrightarrow \cdots \longrightarrow {}'^{a}ya\check{s}\check{s}ebQ_{1,1} \longrightarrow {}'^{a}ya\check{s}\check{s}eb$$

$$C_{1,2,5}(\mathbf{V}) \longrightarrow \cdots \longrightarrow yi\check{s}\check{s}\acute{e}bQ_{1,2} \longrightarrow yi\check{s}\check{s}\acute{e}btiy \longrightarrow_{(4.3)} yi\check{s}\check{s}abtiy$$

12 Weak verbs with $M = y$ or w

Most difficult among weak verbs are those whose middle radical y or w is unable to decide whether it is a consonant or a vowel. Weingreen discusses the following three examples: *qwmoa*, *šyméa* and *kwn*, the last not known in pattern 1.

To start with, we require the following rewrite rules:

$$iCwo \longrightarrow \bar{a}C[uw] \tag{12.1}$$

$$iCw\acute{e} \longrightarrow \bar{a}C[ey] \tag{12.2}$$

$$iCwa \longrightarrow \bar{a}C[ow] \tag{12.3}$$

We have already discussed the symbol $[ey]$ in Section 6 and we now introduce the following rules for evaluating $[uw]$ and $[ow]$.

$$[uw] \longrightarrow \left\{ \begin{array}{cl} o & \text{before } CC' \\ uw & \text{before } C\bar{V} \text{ or } C\# \end{array} \right. \tag{12.4}$$

$$[ow] \longrightarrow \left\{ \begin{array}{cl} \dot{a} & \text{before } Ct\ddot{a}m \\ o & \text{before } CC' \text{ otherwise} \\ uw & \text{before } CV \\ ow & \text{before } C\bar{V} \text{ or } C\# \end{array} \right. \tag{12.5}$$

We can now make some sample calculations for $\mathbf{V} = qwmoa$ "to arise".

$$C_{1,1,1}(\mathbf{V}) \longrightarrow P_{1,1}S_{1,1}(\mathbf{V})Q_{1,1} \longrightarrow {}'S_{1,1}(\mathbf{V})Q_{1,1} \longrightarrow {}'iqwomQ_{1,1}$$
$$\longrightarrow_{(12.1)} {}'\bar{a}q[uw]mQ_{1,1} \longrightarrow {}'\bar{a}q[uw]m \longrightarrow_{(12.4)} {}'\bar{a}quwm$$

$$C_{6f,1,1}(\mathbf{V}) \longrightarrow \cdots \longrightarrow t\bar{a}q[uw]mn\bar{a}h \longrightarrow_{(12.4)} t\bar{a}qomn\bar{a}h$$

At least, this is the form presented by Halkin, but Weingreen follows a different strategy for avoiding the impossible combination *wmn* and obtains $t^e quwm\bar{a}yn\bar{a}h$ instead. Calculating $C_{6f,1,1}(\mathbf{V}')$ for $\mathbf{V}' = \check{s}ym\acute{e}a$ "to place", both authors obtain *tāšemnāh*, easily calculated with the help of our old rules for evaluating $[ey]$, as well as the alternative form $t^e\check{s}iym\ddot{a}yn\bar{a}$. We will now discuss how the alternative forms are to be constructed. The following rules introduce so-called "buffer vowels" between two consonants C' and C'', hence we postulate: before C''.

$$\bar{a}C[uw]C' \longrightarrow^{e} CuwC'\ddot{a}y \tag{12.6}$$

$$\bar{a}C[ey]C' \longrightarrow^{e} CiwC'\ddot{a}y \tag{12.7}$$

$$\bar{a}C[ow]C' \longrightarrow^{e} CuwC'o \tag{12.8}$$

$$\bar{a}C[ay]C' \longrightarrow^{e} CiyC'ow \tag{12.9}$$

To handle the past tense, we require furthermore:

$$\bar{a}wa, \bar{a}ya \longrightarrow \begin{cases} \bar{a} & \text{before } C\bar{V} \text{ or } C\# \\ a & \text{before } CC' \end{cases} \tag{12.10}$$

$$^{e}wa \longrightarrow a \text{ before } CC' \tag{12.11}$$

allowing us to calculate
$C_{1,2,1}(\mathbf{V}) \longrightarrow S_{2,1}(\mathbf{V})Q_{1,2} \longrightarrow [q\bar{a}wam]Q_{1,2} \longrightarrow [q\bar{a}wam]tiy$
$\longrightarrow_{(6.9)} q\bar{a}wamtiy \longrightarrow_{(12.10)} qamtiy$

$C_{3m,2,1}(\mathbf{V}) \longrightarrow \cdots \longrightarrow q\bar{a}wam \longrightarrow_{(12.10)} q\bar{a}m$

$C_{5m,2,1}(\mathbf{V}) \longrightarrow \cdots \longrightarrow [q\bar{a}wam]t\ddot{a}m \longrightarrow_{(6.9)} q^{e}wamt\ddot{a}m \longrightarrow_{(12.11)} qamt\ddot{a}m$

Similarly we obtain *šamtiy*, *šām* and *šamtäm*.
To deal with the second pattern, we require another rule:

$$\bar{a}w\acute{e} \longrightarrow [ow]. \tag{12.12}$$

We will now calculate $C_{1,1,2}(\mathbf{V})$. But since $\mathbf{V} = qwmoa$ does not possess a passive, we replace it by $\mathbf{V}' = kwn$ (the characteristic vowels being irrelevant.)

$C_{1,1,2}(\mathbf{V}') \longrightarrow \cdots \longrightarrow$ *'äkkāwén* $\longrightarrow_{(12.12)}$ *'äkk[ow]n* $\longrightarrow_{(12.5)}$ *'äkkown*

$C_{6f,1,2}(\mathbf{V}') \longrightarrow \cdots \longrightarrow$ *tikkāwénnāh* $\longrightarrow_{(12.12)}$ *tikk[ow]nnāh* $\longrightarrow_{(12.5)}$ *tikkonnāh*

At least, this is Halkin's result. Weingreen, unaccountably, omits this form.

$C_{1,2,2}(\mathbf{V}') \longrightarrow S_{1,2}(\mathbf{V}')Q_{1,2} \longrightarrow nikwanQ_{1,2} \longrightarrow_{(12.3)} n\bar{a}k[ow]nQ_{1,2} \longrightarrow n\bar{a}k[ow]ntiy \longrightarrow_{(12.8)} n^ekuwnotiy$

$C_{3m,2,2}(\mathbf{V}') \longrightarrow \cdots \longrightarrow n\bar{a}k[ow]n \longrightarrow_{(12.5)} n\bar{a}kown$

$C_{3f,2,2}(\mathbf{V}') \longrightarrow \cdots \longrightarrow n\bar{a}k[ow]nt \longrightarrow_{(12.8)} n^ekuwnot$

$C_{4,2,2}(\mathbf{V}') \longrightarrow \cdots \longrightarrow n\bar{a}k[ow]nnuw \longrightarrow_{(12.8)} n^ekuwnonuw$

For the third and fourth pattern, we require new rewrite rules:

$$\left.\begin{array}{rcl} aCw & \longrightarrow & \bar{a}C \\ iCw & \longrightarrow & eC \\ \dot{a}Cw & \longrightarrow & uwC \end{array}\right\} \text{before } [ey] \text{ or } [ay] \tag{12.13}$$

$C_{1,1,3}(\mathbf{V}) \longrightarrow P_{1,1}S_{1,3}(\mathbf{V})Q_{1,1} \longrightarrow {}'S_{1,3}(\mathbf{V})Q_{1,1} \longrightarrow {}'haqw[ey]mQ_{1,1} \longrightarrow_{(6.3)} {}'aqw[ey]mQ_{1,1} \longrightarrow_{(12.13)} \bar{a}q[ey]mQ_{1,1} \longrightarrow {}'\bar{a}q[ey]m \longrightarrow_{(6.7)} {}'\bar{a}qiym$

$C_{6f,1,3}(\mathbf{V}) \longrightarrow \cdots \longrightarrow t\bar{a}q[ey]mn\bar{a}h \longrightarrow_{(6.7)} t\bar{a}qemn\bar{a}h$
though Weingreen offers the alternative $t^eqiym\ddot{a}yn\bar{a}h$, which may be justified by (12.7).

$C_{1,2,3}(\mathbf{V}) \longrightarrow \cdots \longrightarrow hiqw[ay]mQ_{1,2} \longrightarrow_{(12.13)} heq[ay]mQ_{1,2} \longrightarrow heq[ay]mtiy \longrightarrow_{(6.8)} heqamtiy$
where again Weingreen offers the alternative $h^aqiymowtiy$, although we would predict $(\quad)^e$ instead of $(\quad)^a$ by (12.8).

$C_{6f,2,3}(\mathbf{V}) \longrightarrow \cdots \longrightarrow heq[ay]muw \longrightarrow heqiymuw$

$C_{1,1,4}(\mathbf{V}) \longrightarrow \cdots \longrightarrow \text{'}\dot{a}qwamQ_{1,1} \longrightarrow_{(12.13)} \text{'}uwqamQ_{1,1} \longrightarrow \text{'}uwqam$

$C_{6f,1,4}(\mathbf{V}) \longrightarrow \cdots \longrightarrow tuwqamn\bar{a}h$

$C_{1,2,4}(\mathbf{V}) \longrightarrow \cdots \longrightarrow huwqamQ_{1,2} \longrightarrow huwqam$

$C_{6f,2,4}(\mathbf{V}) \longrightarrow \cdots \longrightarrow huwqamuw \longrightarrow_{(4.1)} huwq^{e}muw$

The pattern 5,6 and 7 for verbs with medial y or w were only used in late biblical times. Due to a reluctance to double the medial y or w, the triliteral root *qwmoa* was replaced by the quadriliteral *qwmm*. See Section 8 above.

13 Weak verbs with $M = (w)$, a potential w

The stative verbs $m(w)ta\acute{e}$"to die" and $b(w)\check{s}ao$ "to be ashamed" require special consideration. Here (w) denotes a potential w, to be distinguished from an actual w and subject to the following rewrite rules:

$$\bar{a}(w)o \longrightarrow [ow] \tag{13.1}$$

$$\bar{a}(w) \longrightarrow \emptyset \qquad \text{when not followed by } o \tag{13.2}$$

$$e(w) \longrightarrow \emptyset \qquad \text{before } \dot{a} \tag{13.3}$$

$$(w) \longrightarrow w \qquad \text{otherwise.} \tag{13.4}$$

Here are some sample calculations:

$C_{1,1,1}(\mathbf{V}) \longrightarrow \cdots \longrightarrow \text{'}im(w)atQ_{1,1} \longrightarrow \text{'}\bar{a}m(w)atQ_{1,1} \longrightarrow \text{'}\bar{a}mwatQ_{1,1}$
$\longrightarrow \text{'}\bar{a}m[uw]tQ_{1,1} \longrightarrow \text{'}\bar{a}m[uw]t \longrightarrow_{(12.4)} \text{'}\bar{a}muwt$

$C_{6f,1,1}(\mathbf{V}) \longrightarrow \cdots \longrightarrow t\bar{a}m[uw]tn\bar{a}h \longrightarrow_{(12.4)} t\bar{a}motn\bar{a}h$
with an alternative $t^{e}muwt\ddot{a}yn\bar{a}h$ by (12.6).

$C_{1,2,1}(\mathbf{V}) \longrightarrow S_{2,1}(\mathbf{V})Q_{1,2} \longrightarrow [m\bar{a}(w)\acute{e}t]Q_{1,2} \longrightarrow [m\bar{a}(w)\acute{e}t]tiy$
$\longrightarrow_{(6.9)} m\bar{a}(w)\acute{e}ttiy \longrightarrow_{(13.2)} m\acute{e}ttiy \longrightarrow_{(4.3)} mattiy$

$C_{3m,2,1}(\mathbf{V}) \longrightarrow \cdots \longrightarrow m\bar{a}(w)\acute{e}t \longrightarrow_{(13.2)} m\acute{e}t \longrightarrow_{(4.3)} met$

$C_{6f,2,1}(\mathbf{V}) \longrightarrow \cdots \longrightarrow m\bar{a}(w)\acute{e}tuw \longrightarrow_{(13.2)} m\acute{e}tuw \longrightarrow_{(4.3)} metuw$

Pattern 2 does not exist for $m(w)ta\acute{e}$. For patterns 3 and 4, we adopt the rules:

$$\left.\begin{array}{r}aC(w) \longrightarrow \bar{a}C\\ iC(w) \longrightarrow eC\\ uC(w) \longrightarrow uwC\end{array}\right. \qquad \text{before } [ey] \text{ or } [ay] \tag{13.5}$$

$C_{1,1,3}(\mathbf{V}) \longrightarrow \cdots \longrightarrow \text{'}am(w)[ey]tQ_{1,1} \longrightarrow_{(13.5)} \text{'}\bar{a}m[ey]tQ_{1,1}$
$\longrightarrow \text{'}\bar{a}m[ey]t \longrightarrow_{(6.7)} \text{'}\bar{a}miyt$

$C_{6f,1,3}(\mathbf{V}) \longrightarrow \cdots \longrightarrow t\bar{a}m[ey]tn\bar{a}h \longrightarrow_{(6.7)} t\bar{a}metn\bar{a}h$
with the alternative $t^emiyt\ddot{a}yn\bar{a}h$ by (12.7).

$C_{1,2,3}(\mathbf{V}) \longrightarrow \cdots \longrightarrow him(w)[ay]tQ_{1,2} \longrightarrow_{(13.5)} hem[ay]tQ_{1,2}$
$\longrightarrow hem[ay]ttiy \longrightarrow_{(6.8)} hemattiy$

$C_{6f,2,3}(\mathbf{V}) \longrightarrow \cdots \longrightarrow hem[ay]tuw \longrightarrow_{(6.8)} hemiytuw$

$C_{1,1,4}(\mathbf{V}) \longrightarrow \cdots \longrightarrow hum(w)atQ_{1,2} \longrightarrow_{(13.5)} huwmatQ_{1,2} \longrightarrow huwmattiy$

$C_{6f,2,4}(\mathbf{V}) \longrightarrow \cdots \longrightarrow huwmatuw \longrightarrow_{(4.1)} huwm^etuw$

To obtain patterns 5 and 6, we must replace the triliteral $m(w)ta\acute{e}$ by the quadrilitiral $mwtt$.

Next, consider $\mathbf{V} = b(w)\check{s}ao$. Then we calculate:

$C_{1,1,1} \longrightarrow \cdots \longrightarrow\ 'ib(w)a\check{s}Q_{1,1} \longrightarrow_{(13.1)}\ 'eb[ow]\check{s}Q_{1,1} \longrightarrow\ 'eb[ow]\check{s}$
$\longrightarrow_{(12.5)}\ 'ebow\check{s}$

$C_{6f,1,1}(\mathbf{V}) \longrightarrow \cdots \longrightarrow teb[uw]\check{s}n\bar{a}h \longrightarrow_{(12.4)} tebo\check{s}n\bar{a}h$

$C_{1,2,1}(\mathbf{V}) \longrightarrow \cdots \longrightarrow b\bar{a}(w)o\check{s}Q_{1,2} \longrightarrow b[ow]\check{s}Q_{1,2} \longrightarrow_{(13.1)} b[ow]\check{s}tiy$
$\longrightarrow_{(12.5)} bo\check{s}tiy$

$C_{3m,2,1}(\mathbf{V}) \longrightarrow \cdots \longrightarrow [b\bar{a}(w)o\check{s}]Q_{5m,2} \longrightarrow [b\bar{a}(w)o\check{s}]t\ddot{a}m \longrightarrow_{(6.9)} b^e(w)\dot{a}\check{s}t\ddot{a}m$
$\longrightarrow b^e(w)\dot{a}\check{s}t\ddot{a}m \longrightarrow b\dot{a}\check{s}t\ddot{a}m$

14 Weak verbs with $L = y$ or w

As already mentioned, the traditional $L = h$ should really be treated as $L = y$ or w. For example, consider $\mathbf{V} = qly\acute{e}a$. The easiest way to describe the conjugation of these verbs is by revising Table II above as follows:

Table IIb

Stem Rewrite Rules for $L = y$ or w

k	Pattern	Future $S_{1,k}(\mathbf{V})$	Past $S_{2,k}(\mathbf{V})$
1	qal	$iFM[\ddot{a}y]$	$[F\bar{a}M[iy]]$
2	niph‘al	$niFF\bar{a}M[\ddot{a}y]$	$niFM[iy]$
3	hiph‘il	$hiFM[\ddot{a}y]$	$hiFM[iy]$
4	hoph‘al	$h\dot{a}FM[\ddot{a}y]$	$h\dot{a}FM[iy]$
5	pi‘el	$iFaMM[\ddot{a}y]$	$FiMM[iy]$
6	pu‘al	$iFuMM[\ddot{a}y]$	$FuMM[iy]$
7	hitpa‘el	$hit + FaMM[\ddot{a}y]$	$hit + FuMM[iy]$

where

$$[\ddot{a}y] \longrightarrow \begin{cases} \emptyset & \text{before a long vowel} \\ \ddot{a}h & \text{before } \# \\ \ddot{a}y & \text{before } n\bar{a}h \end{cases} \qquad (14.1)$$

and

$$[iy] \longrightarrow \begin{cases} \emptyset & \text{before } uw \\ {}^{e}t & \text{before } \bar{a}h \\ \bar{a}h & \text{before } \# \\ iy & \text{otherwise} \end{cases} \tag{14.2}$$

When $k = 3$ to 7, iy may or must be replaced by ey; see Weingreen pages 218 to 220 for details .

Sample calculations for $\mathbf{V} = gly\acute{e}a$:

$$C_{1,1,1}(\mathbf{V}) \longrightarrow \cdots \longrightarrow \text{'}\ddot{a}gl\ddot{a}h$$

$$C_{2f,1,1}(\mathbf{V}) \longrightarrow \cdots \longrightarrow tigl[\ddot{a}y]iy \longrightarrow_{(14.1)} tigliy$$

$$C_{6f,1,1}(\mathbf{V}) \longrightarrow \cdots \longrightarrow tigl[\ddot{a}y]n\bar{a}h \longrightarrow_{(14.1)} tigl\ddot{a}yn\bar{a}h$$

$$C_{1,2,1}(\mathbf{V}) \longrightarrow \cdots \longrightarrow g\bar{a}[iy]tiy \longrightarrow_{(14.2)} g\bar{a}liytiy$$

$$C_{3m,2,1}(\mathbf{V}) \longrightarrow \cdots \longrightarrow g\bar{a}l[iy] \longrightarrow_{(14.2)} g\bar{a}l\bar{a}h$$

$$C_{3f,2,1}(\mathbf{V}) \longrightarrow \cdots \longrightarrow g\bar{a}l[iy]\bar{a}h \longrightarrow_{(14.2)} g\bar{a}l^{e}t\bar{a}h$$

$$C_{6f,2,1}(\mathbf{V}) \longrightarrow \cdots \longrightarrow g\bar{a}l[iy]uw \longrightarrow_{(14.2)} g\bar{a}luw$$

$$C_{5m,2,1}(\mathbf{V}) \longrightarrow \cdots \longrightarrow [g\bar{a}l[iy]]t\ddot{a}m \longrightarrow_{(14.2)} [g\bar{a}liy]t\ddot{a}m \longrightarrow_{(6.9)} g^{e}liyt\ddot{a}m$$

15 Weak verbs with $M = L$

The so-called "doubled" verbs with $M = L$ give rise to a number of complications. Weingreen treats two examples: the active verb *sbboa* and the stative verb *qllaa*, the former only in patterns 1,2 and 3, the latter only in pattern 1. Are we to infer that then verbs are regular in patterns 5,6 and 7?

Let us consider $\mathbf{V} = sbboa$. A straight forward calculation would yield $C_{1,1,1}(\mathbf{V}) \longrightarrow$ *'äsbob*. It is difficult to see why this form was not acceptable to the ancient Hebrews, but apparently it was not. In fact, Weingreen offers two alternatives for $C_{1,1,1}(\mathbf{V})$, namely *'āsob* and *'ässob*. The second form suggests that we are dealing with a different verb altogether, namely *ssboa* with $M = F$. Perhaps the verb in question originally had only two radicals and the doubling of M was merely a device to force it into the triliteral straight-jacket. The second alternative seems to be acceptable for the entire future of pattern 1, and its conjugation is quite regular. For the first alternative, which applies also to the past of pattern 1 and to both tenses of patterns 2,3 and 4, the easiest way is to rewrite Table II as follows:

Table IIc

Stem Rewrite Rules for $M = L$

k	Pattern	Future $S_{1,k}(\mathbf{V})$	Past $S_{2,k}(\mathbf{V})$
1	qal	$\bar{a}F\alpha_1(MM)$	$F\alpha_2(MM)$
2	niph'al	$niFFa(MM)$	$n\bar{a}Fa(MM)$
3	hiph'il	$h\bar{a}Fe(MM)$	$heFe(MM)$
4	hoph'al	$huwFa(MM)$	$huwFa(MM)$

where

$$(CC) \longrightarrow \begin{cases} C & \text{before } \# \\ CC & \text{before a long vowel} \\ CC\ddot{a}y & \text{before } n\bar{a}h \\ CCow & \text{otherwise} \end{cases} \tag{15.1}$$

The *äy* and *ow* serve as long buffer vowels.

We present some sample calculations for $\mathbf{V} = sbboa$, but with some question marks that will require an explanation.

$$C_{1,1,1}(\mathbf{V}) \longrightarrow \cdots \longrightarrow \text{'}\bar{a}so(bb) \longrightarrow_{(15.1)} \text{'}\bar{a}sob$$

$$C_{6f,1,1}(\mathbf{V}) \longrightarrow \cdots \longrightarrow t\bar{a}so(bb)n\bar{a}h \longrightarrow_{(15.1)} t\bar{a}sobb\ddot{a}yn\bar{a}h \longrightarrow^{?} t^{e}subb\ddot{a}yn\bar{a}h$$

$$C_{1,2,1}(\mathbf{V}) \longrightarrow \cdots \longrightarrow sa(bb)tiy \longrightarrow_{(15.1)} sabbowtiy$$

$$C_{3m,2,1}(\mathbf{V}) \longrightarrow \cdots \longrightarrow sa(bb) \longrightarrow_{(15.1)} sab$$

$$C_{6f,2,1}(\mathbf{V}) \longrightarrow \cdots \longrightarrow sa(bb)uw \longrightarrow_{(15.1)} sabbuw$$

$$C_{1,1,2}(\mathbf{V}) \longrightarrow \cdots \longrightarrow \text{'}\ddot{a}ssa(bb) \longrightarrow_{(15.1)} \text{'}\ddot{a}ssab$$

$$C_{3m,1,2}(\mathbf{V}) \longrightarrow \cdots \longrightarrow yissa(bb) \longrightarrow_{(15.1)} yissab$$

$$C_{6f,1,2}(\mathbf{V}) \longrightarrow \cdots \longrightarrow tissa(bb)n\bar{a}h \longrightarrow_{(15.1)} tissabb\ddot{a}yn\bar{a}h$$

$$C_{1,2,2}(\mathbf{V}) \longrightarrow \cdots \longrightarrow n\bar{a}sa(bb)tiy \longrightarrow_{(15.1)} n\bar{a}sabbowtiy \longrightarrow^{?} n^{e}sabbowtiy$$

$$C_{3m,2,2}(\mathbf{V}) \longrightarrow \cdots \longrightarrow n\bar{a}sa(bb) \longrightarrow_{(15.1)} n\bar{a}sab$$

$$C_{6f,2,2}(\mathbf{V}) \longrightarrow \cdots \longrightarrow n\bar{a}sa(bb)uw \longrightarrow_{(15.1)} n\bar{a}sabbuw$$

$$C_{1,1,3}(\mathbf{V}) \longrightarrow \cdots \longrightarrow \text{'}\bar{a}se(bb) \longrightarrow_{(15.1)} \text{'}\bar{a}seb$$

$$C_{6f,1,3}(\mathbf{V}) \longrightarrow \cdots \longrightarrow t\bar{a}se(bb)n\bar{a}h \longrightarrow_{(15.1)} t\bar{a}sebb\ddot{a}yn\bar{a}h \longrightarrow^{?} t^{e}sibb\ddot{a}yn\bar{a}h$$

$$C_{1,2,3}(\mathbf{V}) \longrightarrow \cdots \longrightarrow hese(bb)tiy \longrightarrow_{(15.1)} hesebbowtiy \longrightarrow^{?} h^{a}sibbowtiy$$

$$C_{3m,2,3}(\mathbf{V}) \longrightarrow \cdots \longrightarrow hese(bb) \longrightarrow_{(15.1)} heseb$$

$$C_{1,1,4}(\mathbf{V}) \longrightarrow \cdots \longrightarrow \text{'}uwsa(bb) \longrightarrow_{(15.1)} \text{'}uwsab$$

$$C_{6f,1,4}(\mathbf{V}) \longrightarrow \cdots \longrightarrow tuwsa(bb)n\bar{a}h \longrightarrow_{(15.1)} tuwsabb\ddot{a}yn\bar{a}h$$

$$C_{1,2,4}(\mathbf{V}) \longrightarrow \cdots \longrightarrow huwsa(bb)tiy \longrightarrow_{(15.1)} huwsabbowtiy$$

$$C_{3m,2,4}(\mathbf{V}) \longrightarrow \cdots \longrightarrow huwsa(bb) \longrightarrow_{(15.1)} huwsab$$

$$C_{6f,2,4}(\mathbf{V}) \longrightarrow \cdots \longrightarrow huwsa(bb)n\bar{a}h \longrightarrow_{(15.1)} huwsabb\ddot{a}yn\bar{a}h$$

The question marks in the above calculations indicate a missing explanation for the change of the two vowels before the long buffer vowels is reached. The problem is that our system does not take the accent of the vowel into account. We can fix the problem but our solution seems a bit *ad hoc*. We are forced to adopt the following awkward revisions:

$$\left.\begin{array}{rcl} \bar{a}FoMM & \longrightarrow & {}^{e}FuMM \\ \bar{a}FaMM & \longrightarrow & {}^{e}FaMM \\ \bar{a}FeMM & \longrightarrow & {}^{e}FiMM \\ eFeMM & \longrightarrow & {}^{a}FiMM \end{array}\right\} \text{ before a long buffer vowel } \ddot{a}y \text{ or } ow \quad (15.2)$$

What is the rationale behind these revisions? First, the initial vowel must be shortened when too far removed from the stressed syllable, and so $\bar{a} \longrightarrow^{e}$, and $e \longrightarrow^{a}$. Second, as we have already noticed, when unstressed, $o \longrightarrow u$ and $e \longrightarrow i$ before CC. We had hoped that the verb $\mathbf{V}' = qllaa$ "to be light" would be covered by the same rules. Unfortunately, we cannot explain why $C_{1,1,1}(\mathbf{V}') \longrightarrow$ '*eqal* rather than '*āqal* as expected, except by modifying Table IIc accordingly.

16 Doubly weak verbs

Doubly weak verbs are verbs that have two radicals that are weak. Its seems that one has to work with the rules of each radical one at a time. All our examples worked by applying the rules from left to right.

We begin with the verb that starts with an assimilative $F = (n)$ and concludes with a guttural $L =$ ‘. The verb is $\mathbf{V} = (n)g\text{‘}aa$ “to touch”.

$C_{1,2,1}(\mathbf{V}) \longrightarrow \cdots \longrightarrow [(n)\bar{a}ga\text{‘}]Q_{1,2} \longrightarrow_{(6.9)} (n)\bar{a}ga\text{‘}Q_{1,2}$
$\longrightarrow_{(9.2)} n\bar{a}ga\text{‘}Q_{1,2} \longrightarrow n\bar{a}ga\text{‘}tiy$

$C_{3f,1,1}(\mathbf{V}) \longrightarrow \cdots \longrightarrow ti(n)ga\text{‘}Q_{3f,1} \longrightarrow_{(9.1)} tigga\text{‘}Q_{3f,1} \longrightarrow tiygga\text{‘}Q_{3f,1}$
$\longrightarrow tiygga\text{‘}$

$C_{3f,1,3}(\mathbf{V}) \longrightarrow \cdots \longrightarrow tha(n)g[ey]\text{‘}Q_{3f,1} \longrightarrow_{(6.3)} ta(n)g[ey]\text{‘}Q_{3f,1}$
$\longrightarrow tagg[ey]\text{‘}Q_{3f,1} \longrightarrow tagg[ey]\text{‘} \longrightarrow_{(6.8)} taggiy\text{‘} \longrightarrow_{(10.6)} taggiya\text{‘}$

$C_{6f,2,3}(\mathbf{V}) \longrightarrow \cdots \longrightarrow hi(n)g[ay]\text{‘}Q_{6f,2} \longrightarrow_{(9.1)} higg[ay]\text{‘}Q_{6f,2} \longrightarrow higgiy\text{‘}Q_{6f,2}$
$\longrightarrow higgiy\text{‘}uw$

Another doubly weak verb is $\mathbf{V} = (n)\acute{s}\text{’}aa$ “to raise”. We require a new rule supplementing (4.1):

$$a \longrightarrow \bar{a} \text{ before ’}. \tag{16.1}$$

$C_{1,1,1}(\mathbf{V}) \longrightarrow \cdots \longrightarrow \text{’}i(n)\acute{s}a\text{’}Q_{1,1} \longrightarrow_{(6.5)} \text{’}\ddot{a}(n)\acute{s}a\text{’}Q_{1,1} \longrightarrow_{(9.1)} \text{’}\ddot{a}\acute{s}\acute{s}a\text{’}Q_{1,1}$
$\longrightarrow \text{’}\ddot{a}\acute{s}\acute{s}a\text{’} \longrightarrow_{(15.2)} \text{’}\ddot{a}\acute{s}\acute{s}\bar{a}\text{’}$

$C_{1,2,1}(\mathbf{V}) \longrightarrow \cdots \longrightarrow [(n)\bar{a}\acute{s}a\text{’}]Q_{1,2} \longrightarrow_{(6.9)} (n)\bar{a}\acute{s}a\text{’}Q_{1,2} \longrightarrow_{(9.2)} n\bar{a}\acute{s}a\text{’}Q_{1,2}$
$\longrightarrow n\bar{a}\acute{s}a\text{’}tiy \longrightarrow_{(15.2)} n\bar{a}\acute{s}\bar{a}\text{’}tiy$

$C_{2m,2,2}(\mathbf{V}) \longrightarrow \cdots \longrightarrow ni(n)\acute{s}a\text{’}Q_{2m,2} \longrightarrow_{(9.1)} ni\acute{s}\acute{s}a\text{’}Q_{2m,2} \longrightarrow_{(10.9)} ni\acute{s}\acute{s}e\text{’}Q_{2m,2}$
$\longrightarrow ni\acute{s}\acute{s}e\text{’}t\bar{a}$

Now let us calculate a doubly weak verb with $F = (y)/w$. The verb is $\mathbf{V} = (y)d\text{‘}aa/wd\text{‘}aa$“to know”.

$C_{3f,1,1}(\mathbf{V}) \longrightarrow \cdots \longrightarrow ti(y)da\text{‘}Q_{3f,1} \longrightarrow_{(11.6)} teda\text{‘}Q_{3f,a} \longrightarrow teda\text{‘}$

$C_{3f,1,2}(\mathbf{V}) \longrightarrow \cdots \longrightarrow tniww\bar{a}d\acute{e}\text{‘} \longrightarrow_{(6.4)} tiww\bar{a}d\acute{e}\text{‘} \longrightarrow_{(4.3)} tiww\bar{a}da\text{‘}$

$C_{3f,1,7}(\mathbf{V}) \longrightarrow \cdots \longrightarrow thit{+}wadd\acute{e}` \longrightarrow_{(6.3)} tit{+}wadd\acute{e}` \longrightarrow_{(6.6)} titwadd\acute{e}` \longrightarrow_{(4.3)} titwadda`$

And finally, let us do one calculation where both the first and last radicals are gutturals. $\mathbf{V} = `lhaa$ "to ascend".
$C_{3f,1,3}(\mathbf{V}) \longrightarrow \cdots \longrightarrow tha`l[ey]h \longrightarrow_{(6.3)} ta`l[ey]h \longrightarrow_{(10.5)} ta`^{a}l[ey]h \longrightarrow_{(6.7)} ta`^{a}liyh.$
But Weingreen has this as $ta`^{a}l\ddot{a}h$. So, what is wrong here? According to Section 14, the final h should presumably be replaced by y; but this won't help. One solution is to suppliment (6.7) by

$$[ey] \longrightarrow \ddot{a} \text{ before } h. \tag{16.2}$$

There are many more examples that can be easily calculated. However there is not much to gain from going on. We have not found any great surprises. There are two reasons why doubly weak verbs do not seem so hard. First, all the examples that Weingreen describes have a weakness in the first radical and the third radical. Not the second radical. Hence, the second radical separates the two weak radicals. This separation ensures that the different rules do not effect each other. Second, all the examples that Weingreen deals with have the last radical as a guttural. As we have seen, since the last radical is never doubled, there are not many rules that apply to that guttural.

17 Conclusion and a comparison with Arabic

We have shown how the finite forms of the regular verbs can be calculated with the help of certain rewriting rules, embedded in the conjugation formula of Section 6 and tables I and II, together with a few phonological rules. We have also shown how the finite forms of the so-called "weak" verbs can be calculated in the same way, using additional phonological rules. We are not entirely satisfied with our effort, for the following reasons.

- We have ignored the non-finite forms of the verb and the modifications necessary when pronominal suffixes are added.
- The ultimate phonological rules should apply not only to the verb, but to other aspects of biblical Hebrew morphology as well.

- We had started ignoring stress, but were forced to incorporate it into two of our rules, namely (6.8) and (9.3), and to mention it parenthetically after (10.3) and after (15.2).

- The final modifications contained in (15.2) and (16.1) suggest that there are still gaps in our account.

Hebrew resembles Arabic [2] even more closely than English resembles German. For example, a typical verb in both Semitic languages is completely described by three consonants and two vowels. Although classical Hebrew was written down about a thousand years before classical Arabic, its inflectional grammar is much simpler. Like English, it has replaced the cases of the nouns by prepositions and has undergone erosion of many conjugational forms.

Where modern standard Arabic has potentially 18 different patterns, 10 active and 8 passive for each verb, standard Hebrew has only seven[17]. We would therefore expect the computational treatment of Hebrew verbs to be much simpler then that of Arabic ones. Unfortunately, this is not the case, because written Arabic presumably records only phonemes, whereas written Hebrew records either no vowel phonemes or, according to the Masoretic tradition, numerous vowel allophones, which we found difficult to ignore. Hopefully, our approach can also be applied to the pre-Masoretic text, if one starts with the three vowel phonemes a, i and u.

18 Appendix: Waw Conjunctions

Many of the verbs in the Bible start with "and". To write "and" in Hebrew, one prefixes a verb (most of the rules below work for nouns also) with a w. Biblical Hebrew makes use of a strange convention[18]: if two sentences in a continuous narrative both refer to the past (future), then only the first verb is expressed in this tense, while the second is expressed in the future (past) tense preceded by a waw. This works for more than two verbs by continually switching back and forth. The waw switches the tenses.

$$w + C_{i,j,k}(\mathbf{V}) \longrightarrow wC_{i,3-j,k}(\mathbf{V}) \tag{18.1}$$

Such a waw is called a "waw consecutive" (also called "waw conversive").

Punctuating a verb with a w prefix conforms to the following rules:

$$w + C \longrightarrow \begin{cases} w^eC & \text{If the verb is past} \\ waCC & \text{If the verb is future where } C \neq \text{'} \\ w\bar{a}C & \text{If the verb is future where } C = \text{'} \end{cases} \tag{18.2}$$

The third case is actually a specialization of rule (10.3) that deals with gutturals.[19]

For the first rule we have further changes. If the first letter of the word has a shewa, then we change the first shewa into a shuriq:

$$w^eC^e \longrightarrow wuC^e \text{ where } C \neq b, m, p, y. \tag{18.3}$$

Before labials b, m, p, the w also takes a shuriq:

$$w^eL \longrightarrow wuL \text{ where } L = b, m, p. \tag{18.4}$$

Before a y^e, the w takes the ḥireq and the y loses its shewa:

$$w^ey^e \longrightarrow wiy. \tag{18.5}$$

Before a composite shewa, the w takes the corresponding short vowel:

$$w^eC^{\breve{a}} \longrightarrow w\breve{a}C^{\breve{a}}. \tag{18.6}$$

$$w^eC^{\bar{a}} \longrightarrow w\bar{a}C^{\bar{a}}. \tag{18.7}$$

$$w^eC^{a} \longrightarrow waC^{a}. \tag{18.8}$$

Notes

[1] With some stretch of the imagination, the connection between these two concepts can be seen in English also. A man who demands honor does "not take himself lightly."

[2]Judges 12. As far as we know, the distinction between $\check{s}$ and $\acute{s}$ is not explained by any phonetic rule, but that between b and b^h is.

[3]See Gesenius Section 7a.

[4]According to [3], the main reason for the Masoretic enterprise was to ensure that these attached consonants do not make their way into the sacred texts. They are used to represent vowels in written Yiddish.

[5]There are two other Masoretic traditions: Babylonian and Yemenite. They have different symbols and different conventions. For example, they make no distinction between a (patach) and $\ddot{a}$ (segol). We shall only deal with the more commonly used Tiberian system.

[6]There has been much variation in pronunciation even after the introduction of the Masoretic symbols. Within the last two centuries, the Hasidic pronunciation has varied widely from the "standard" Ashkenazi pronunciation from which it sprang. Hasidim are in the habit of effectively adding a consonant y after every e ($\d{S}ere$). So they go from $sef\ddot{a}r$ to $seyf\ddot{a}r$. Their pronunciation of $Tor\bar{a}h$ is $Toyr\bar{a}h$.

[7]Within classical Rabbinic Judaism, there is some discussion about the Talmud not having the exact (consonant) spelling of certain words (e.g., Babylonian Talmud Kiddushin 30a). Furthermore, Rabbi Akiva Eiger Guenz (1761-1835) gives a list of places where the Rabbinic tradition of the Bible text conflicts with our accepted text *op. cit.* Babylonian Talmud Saabath 55b. See also Nedarim 38a. There is much discussion on the varieties of "the" Masoretic text and the elasticity of the text in the passing millennia. One imagines that this uncertainty would extend from written consonants to the unwritten vowel pronunciation. c.f. Nehemiah 8:8. We shall not go into this.

[8] The traditional names of the short vowels are:

$$\begin{array}{ccccccccc} &&&patah\!\!\!.&&&&& \\ &&segol&&&q\bar{a}me\d{s}-katan&&& \\ &\d{s}ere&&&&&&\d{h}olem& \\ \d{h}ireq&&&&&&&&qibbus \end{array}$$

The names of the long vowels are:

$$\begin{array}{ccccccc} &&&q\bar{a}me\d{s}-gadol&&& \\ &\d{s}ere-yud&&&&\d{h}olem& \\ \d{h}ireq-yud&&&&&&\check{s}ureq \end{array}$$

[9]Denoting the silent shewa as ^{s} and the mobile/vocalic shewa as ^{m}, we might write some of the easier rules as follows:
A. In the middle of a word, when there are two shewas in a row, the first one is a silent shewa and the second one is a mobile one:

$$CVX^eX'^eC' \longrightarrow CVX^sX'^mC'.$$

B. When a shewa is under a doubled letter(usually indicated by a dot=dagesh), then the above rule applies:

$$X^e\cdot = X^eX^e \longrightarrow X^sX^m.$$

C. After a long vowel, the syllable is over and the following shewa is a mobile/vocalic shewa starting the next syllable. In contrast, after a short vowel, the following shewa is finishing that syllable and hence is a silent shewa:

$$C\bar{V}X^e \longrightarrow C\bar{V}X^m \text{ where } \bar{V} = \bar{a}, ey, iy, uw, ow$$

$$CVX^e \longrightarrow CVX^s \text{ where } V = a, \ddot{a}, \dot{a}, i$$

[10]One of the most surprising facts about Hebrew grammar is how late the triliteralness of Hebrew words was recognized. Although this seems obvious to us, it was not known until Yehuda ibn David Hayyuj (940 - 1010) wrote of it. It seems Rashi (1040 - 1105), the "first of the commentators", was not aware of this or not convinced of it. For Rashi, words might have three literal roots (e.g., Exodus 23:27, Deuteronomy 12:30, Deuteronomy 32:26), but more

commonly two letter roots (e.g., Genesis 2:19, Genesis 3:15, Numbers 22:32) and even one letter roots (e.g., Numbers 21:11).

[11]This categorization exists in Arabic also.

[12]There are actually many other less common patterns found in the Bible. Some are more common in Mishnaic, medieval, and modern Hebrew. There are: po'el, hitpo'el; pa'lel, hitpa'lel; p^e'al'al; pilpel, hitpilpel; tiph'el; šaph'el as well as several others.

[13]The only exception to the first case we have found is *w^{e}hitšoṭaṭnāh* (Jeremiah 49:3) avoiding three t-sounds in close proximity.

[14]Weingreen is following a long tradition of using this word. Ḳimḥi uses the more peaceful verb *pqdoa* "to visit"; but *qṭloa* has the advantage of being similar in other Semitic languages and so is used in comparative linguistics. It has the disadvantage of not being found that often in the Hebrew Bible (only Psalms 139:14; Job 13:15; Job 24:14 c.f. Obadiah 1:9.). Its Aramaic equivalent occurs seven times in Daniel.

[15]Some of the more interesting five-letter nouns are:

- *šalhābät* "flame" (Job 15:30 and Canticles 8:6). Most scholars take this to be a case of a conjugation of the word *lāb* by a very strange šaph'el pattern.
- *ṣ^{e}pardde'a* "frog" (Exodus Chaps 7 and 8, Psalms 78:45, 105:30).
- *ḥ^{a}baṣṣälät* "a lily" or "a meadow saffron" (Canticles 2:1, Isaiah 35:1)
- *ṣalmāwät* "shadow of death" (e.g. Psalms 23:4, Amos 5:8, Job 12:22). This is usually seen as a composite word.

[16]In contrast, Arabic does allow a doubling of a guttural which makes the language significantly harder for a non-native speaker to pronounce.

[17]See however footnote 12.

[18]According to Gesenius [7] page 132, this is one of the most "striking peculiarities" even within the family of Semitic languages. Phoenician is one of the only other Semitic languages that has anything similar.

[19]Some exceptions to the third case are *wa'^{a}gārеš* (in fact, some bibles do have it as *wā'^{a}gārеš*) (Judges 6:9), *wa'^{a}mottehuw* (2Samuel 1:10), and *wa'^{a}kasek* (Ezekiel 16:10).

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19 Postscript

After we completed this article in March 2005, two recent articles dealing with Hebrew morphology were brought to our attention:

[12] R. Finkel and G. Stump, "Generating Hebrew verb morphology by default inheritance hierarchies", University of Kentucky, preprint.

[13] S. Yona and S. Wintner, "A finite-state morphological grammar of Hebrew", to appear in *Natural Language Engineering* 1, received May 2006.

Both papers offer interesting but different computational approaches to Hebrew verb morphology, although to a smaller extent and in less details than ours, which ultimately goes back to Panini and incorporates insights of medieval grammarians.

J. Lambek
Department of Mathematics and Statistics
McGill University
805 Sherbrooke Street West
Montreal, QC, Canada H3A 2K6
email: lambek@math.mcgill.ca

Noson S. Yanofsky
Department of Computer and Information Science
Brooklyn College, CUNY
Brooklyn, N.Y., U.S.A. 11210
email: noson@sci.brooklyn.cuny.edu