Comparison of Pāṇinīya Dhātuvṛttis

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Abstract. In this paper we note the importance of positing a canonical form for verbal root and its meaning to facilitate the comparison of various Dhātuvṛttis. We also provide some quantitative measure of the differences in the Dhātuvṛttis after correlating four Dhātuvṛttis using canonical forms of roots and meanings.

Keywords: Pāṇiniya Dhātupāṭha, canonical form, quantitative analysis.

1 Introduction

Dhātupāṭha is an integral part of the Aṣṭādhyāyī. It consists of a list of verbal roots divided into ten sets called gaṇas. Classification into gaṇas is dictated by the transformations a verbal root undergoes (due to the insertion of a vikaraṇa pratyaya) during the formation of verb conjugations in certain tense/mood known as sārvarṣadhūtaka lakāras. For example, the verbs from dīvādī gaṇa take śyan suffix before a tiṇi suffix indicating a number and a person.

Each verbal root (dhātu) is marked with an accent, meaning and optionally some special markers. Special markers associated with the verbal roots in the Dhātupāṭha either create an environment for application of sūtras or trigger certain morphophonemic changes in the verbal roots under special conditions. For example, the sūtra dvīṭaḥ kṛtiḥ (P3.3.88) allows a ’kṛti’ suffix only in case of verbs with ‘du’ as a marker, such as ’dūkṛti, dūpacaś’ etc. The accents as well as the marker ’n’ indicate a set of terminal suffixes (viz. ātmanepadi or parasmaipadi suffixes) a verb will take. Sometimes the meaning associated with a verbal root also plays an important role in deciding the forms of a verb. For example, the sūtra nāṇcēcī pūjāyam (P6.4.30) prohibits the elision of penultimate ’n’ generated in the process of derivation of verbal conjugations of the root aṅc, if the verb is used in the sense of pūjā ‘worship’. Thus a Dhātupāṭha is not just a list of verbal roots, but each verbal root carries a bundle of information which is essential for the generation of correct forms. Markers in the form of phonemes, accent and the meaning provide scope for the application of certain sūtras during the generation process. In other words there is a tight coupling

1 anudāttanīta ātmanepadām (P1.3.12)
between the information coded with the verb roots in a Dhātupāṭha and the Aṣṭādhyāyī sutra pāṭha. Thus even a slight variation in the Dhātupāṭha would result in wrong conjugation of a verb.

Therefore we expect that the Dhātupāṭha is preserved with special efforts, as is true with the vedas. Ironically we see that there is no consensus regarding the entries of Dhātupāṭha. There are several versions of Dhātupāṭhas and they differ from each other significantly. The accent which carries an important information for the formation of conjugations, and also the nasalisation has been lost over the years. It is surprising that the same tradition which has meticulously preserved the vedas for several centuries devising special methods of recitation, providing enough information for error detection and correction so as to avoid any fault in the transmission, has not paid any attention to preserve the Dhātupāṭha!

There have been efforts to simulate Pāṇinian system by Goyal et al.(2009), Mishra(2009), and Sridhar(2009), and on Modelling Pāṇini by Scharf(2009). These researchers intend to follow the Aṣṭādhyāyī preserving its spirit. For them, therefore, it is crucial to have a Dhātupāṭha with all its variations as reported in various वर्त्तिस in electronic form, to note the effect of variation in the generation.

2 Earlier Work

The concordance of the verbal root was first compiled by Liebich(1928). It contained five Dhātupāṭhas, including three commentaries on Pāṇinīya Dhātupāṭhas. Palsule(1955) added four more non-Pāṇinian Dhātupāṭhas to this work making this work more-or-less complete. The highlights of Palsule’s concordance are

1. It lists all the verbal roots in an alphabetic order and not in the order of Dhātupāṭha.
2. For every root, its गाय्य and पदि as noted in various Dhātupāṭhas is provided.
3. The list of verbal roots also contains roots picked up from
   (a) The St Petersburg Dictionary,
   (b) Sanskrit-English Dictionary by Monier Williams,
   (c) The roots by Whitney, and
   (d) the roots posited by modern scholars.
   Thus his attempt was to make the list of verb roots as complete as possible.
4. In addition to the concordance of verbal roots, his work also consists of an index of meanings. Against each meaning this index provides a list of verbs and the Dhātupāṭhas to which they belong to.

This work is very comprehensive but it suffers from two drawbacks if one wants to use it for computational purpose mentioned earlier.
1. The verb roots do not contain any anubandhas whereas for Pāṇini the starting point of derivation of conjugates is a verbal root with anubandhas. This makes Palsule's concordance unfit for direct use for generation of verbal conjugates following Pāṇini.

2. The index to meanings is arranged alphabetically according to the meanings. For any work on Word Sense Disambiguation in Computational Linguistics, one needs the reverse index viz. a verbal root mapped to the associated meanings.

Further, there is a tight coupling between the Dhātupātha and the sūtras used for generation of verbal conjugations. Hence the purpose of having a concordance of Dhātupāthas in isolation across different grammar systems makes sense only from the meaning point of view and not from the point of view of verb morphology.

3 E-Linked Dhātuṛtis

Advances in technology makes the comparison of Dhātuṛtis easier. Technology further facilitates one to study these Dhātuṛtis from different perspectives. With an aim to link various Dhātuṛtis electronically, and to provide various search facilities over them, we chose the following Pāṇinian Dhātuṛtis.

1. Mādhavya (Gupta, 1991),
2. Kṣirataraṅginī (Mimāṁsakaḥ, 2005),
3. Dhātupradipa (Mimāṁsakaḥ, 1986), and
4. Śabdikābharaṇam (Śukla, 2010).

Roughly all these ṛtis belong to twelfth to fourteenth century. Mādhavya Dhātuṛti is written by Sāyanā, who belonged to late fourteenth century and was with the Vijayanagara emperors Harihara and Bukka. Kṣirasvīniṁ of Kṣirataraṅginī is considered to be from the early twelfth century from Kashmir region. Dhātupradipa is written by Maitreyarakṣitā, a Bengali scholar from the late twelfth century. Śabdikābhaṇām, by Hariyogi, is also probably from the late twelfth century.

Scholars are aware that the Dhātuas listed in various Dhātuṛtis differ from each other and also from what Pāṇini had taught. For example, Brahmadatta Jījīśu (1979) under the commentary on the sūtra upadēsc’ajānunāśika it (P1.3.2) reports that Pāṇini had taught the verbal roots with nasalised sounds, which were lost over a period of time. Observation by Scharf (2009) that ‘The unusual prosody inherent in the canonical form of roots became normalized through the natural adaptation of sequences of sounds to those of ordinary Sanskrit’ provides an useful insight into the possible cause for the variations. The differences may be attributed to the unnatural combinations of phonemes which required special efforts to pronounce and thus to preserve them.

Dhātuas listed in the above Dhātuṛtis differ in following respects.
1. phonemic constituents of the verbal roots,
2. markers attached to them,
3. meaning associated with them,
4. gaṇa they belong to, and
5. the accent.

4 Canonical forms

In order to link these dhātuvṛttis, all of them should follow some uniform naming convention for the verbal root and its meaning.

4.1 Canonical Form of the roots

Scharf(2009) in his digital edition of Madhaviya Dhātuvṛtti proposed the use of canonical form for verb-roots. A canonical form of a verb-root is a sequence of phonemes that conforms to the requirements of rules stated in the Āṣṭāḍhyāyī. These requirements are:

1. The anubandhas are marked.
2. Root vowel accents are marked.
3. Roots retain the following impossible / difficult phonetic combinations.
   (a) an initial ‘ṣ’ and ‘ṛ’ as in ‘ṣṛdaya’.
   (b) dental stops following initial retroflex ‘ś’ as in ‘śṭak’.
   (c) dental ‘ṅ’ instead of homo-organic nasal as in ‘anc’.
   (d) dental ‘ṅ’ instead of anunāsika as in ‘anc’.
   (e) penultimate dental sibilant ‘s’ as in ‘vrasc’.
   (f) penultimate dental ‘d’ as in ‘adṛ’.
   (g) No penultimate ‘c’ before ‘ch’ as opposed to ‘pracch’.

There are rules in Āṣṭāḍhyāyī which when applied to the roots in canonical form normalise them in due course of generation process. The canonical form is required in order to ensure the correct derivation. In some of the cases Dhātuvṛttis do not mention these roots in their canonical form, but the commentary does mention the canonical form and refers to sūtras which change them to normal form. If the vyttikāras did not believe in the canonical form of the roots, they would not have commented about it in the commentaries. So from the very fact that the commentaries support the canonical forms, we may infer that when the Dhātuvṛttis mention the roots in their normal form, it is only from the ease of pronunciation/recitation point of view. So in order to link various Dhātuvṛttis, it is appropriate to map the roots to their canonical forms.
4.2 Canonical forms of meanings

The normal convention of specifying the meaning is using an activity specifying word in the seventh case, such as pājane. Sometimes the word ‘artha’ is used as in gatyārthe. Similarly we found variations among vyttikāras in the use of kṛt suffix to indicate an activity. Some vyttis used ghaṇ suffix while others used lyut suffix to indicate an activity. To make the linking possible, for each of the root, we chose the form that is used by majority of them as the canonical one.

Following information was marked in all the Dhātuvyttis.

1. dhātu with the ‘it’ marker,
2. meaning,
3. meaning analysis,
4. name of the gaṇa the verb belongs to,
5. accent information,
6. pada information,
7. set-anit information,
8. Pāṇinian sūtras, and

In addition, the canonical form for each verb and meaning in seventh case singular form were provided as an extra mark-up for the purpose of linking. These marked up files were then used for the linking.

5 Comparison of Dhātuvyttis

Each entry in the Dhātuvyttti contains one or more roots with one or more meanings associated with it. Since the Dhātuvyttis differ in both the root entries as well as the meaning associated with them, each single entry was expanded into multiple entries with single root, single meaning per entry while comparing them. Thus if there is an entry in a Dhātuvyttti with m roots v₁, v₂, ..., vₘ, with n possible meanings m₁, m₂, ..., mₙ then the entry is expanded into mⁿ distinct (verb, meaning) pairs.

For example an entry such as

gāḍhy pratiśṭhālipsāyoh granthe ca

is expanded into three entries viz.

gāḍhy pratiśṭhāyām,
gāḍhy lipsāyām, and
gāḍhy granthe.
Table 1 shows the number of entries in each Dhātuvr̥tti before and after this expansion. Śābdikābharaṇam does not have any commentary on the verbs from the tenth gaṇa, except for the root cur. This explains the low figure against SB in Table 1.

<table>
<thead>
<tr>
<th>Dhātuvr̥tti</th>
<th>Distinct roots</th>
<th>Distinct root-meaning pairs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mādhaviṇa (MD)</td>
<td>1890</td>
<td>2227</td>
</tr>
<tr>
<td>Kṣirataraṅgini (KT)</td>
<td>1885</td>
<td>2215</td>
</tr>
<tr>
<td>Dhātupradīpa (DP)</td>
<td>1952</td>
<td>2322</td>
</tr>
<tr>
<td>Śābdikabharāṇam (SB)</td>
<td>1157</td>
<td>1407</td>
</tr>
</tbody>
</table>

Table 1

The distribution of roots in various vṛttis among various gaṇas is shown in Table 2.

<table>
<thead>
<tr>
<th>gaṇa</th>
<th>MD</th>
<th>KT</th>
<th>DP</th>
<th>SB</th>
</tr>
</thead>
<tbody>
<tr>
<td>bhvādī</td>
<td>978</td>
<td>995</td>
<td>1031</td>
<td>689</td>
</tr>
<tr>
<td>adādī</td>
<td>72</td>
<td>69</td>
<td>72</td>
<td>71</td>
</tr>
<tr>
<td>juhotyādī</td>
<td>24</td>
<td>25</td>
<td>26</td>
<td>18</td>
</tr>
<tr>
<td>divādī</td>
<td>136</td>
<td>134</td>
<td>139</td>
<td>127</td>
</tr>
<tr>
<td>svādī</td>
<td>29</td>
<td>29</td>
<td>31</td>
<td>25</td>
</tr>
<tr>
<td>tudādī</td>
<td>157</td>
<td>159</td>
<td>168</td>
<td>132</td>
</tr>
<tr>
<td>rudhādī</td>
<td>25</td>
<td>25</td>
<td>25</td>
<td>26</td>
</tr>
<tr>
<td>tanādī</td>
<td>10</td>
<td>9</td>
<td>10</td>
<td>9</td>
</tr>
<tr>
<td>kryādī</td>
<td>60</td>
<td>60</td>
<td>64</td>
<td>59</td>
</tr>
<tr>
<td>curādī</td>
<td>399</td>
<td>381</td>
<td>386</td>
<td>1</td>
</tr>
</tbody>
</table>

Table 2

Some of the roots have multiple meanings. Since not every vṛtti accepts all the meanings, we also compared the vṛttis on the basis of root-meaning pairs. There were 3203 distinct root-meaning pairs found in these four Dhātuvr̥ttis. The distribution of the root-meaning pairs into various gaṇas in various vṛttis is shown in Table 3. It also shows the common root-meaning pairs across all the vṛttis in every gaṇa.
Distribution of root-meaning pairs in different gana

<table>
<thead>
<tr>
<th>gana</th>
<th>MD</th>
<th>KT</th>
<th>DP</th>
<th>SB</th>
<th>matched-entries</th>
</tr>
</thead>
<tbody>
<tr>
<td>bhvādi</td>
<td>1207</td>
<td>1210</td>
<td>1269</td>
<td>865</td>
<td>512</td>
</tr>
<tr>
<td>adādi</td>
<td>84</td>
<td>79</td>
<td>72</td>
<td>81</td>
<td>69</td>
</tr>
<tr>
<td>jahotyādi</td>
<td>34</td>
<td>36</td>
<td>36</td>
<td>25</td>
<td>20</td>
</tr>
<tr>
<td>divādi</td>
<td>157</td>
<td>151</td>
<td>161</td>
<td>152</td>
<td>102</td>
</tr>
<tr>
<td>svādi</td>
<td>39</td>
<td>36</td>
<td>41</td>
<td>28</td>
<td>19</td>
</tr>
<tr>
<td>tudādi</td>
<td>175</td>
<td>176</td>
<td>189</td>
<td>148</td>
<td>92</td>
</tr>
<tr>
<td>rudhādi</td>
<td>32</td>
<td>31</td>
<td>32</td>
<td>26</td>
<td>19</td>
</tr>
<tr>
<td>tanādi</td>
<td>10</td>
<td>9</td>
<td>11</td>
<td>10</td>
<td>7</td>
</tr>
<tr>
<td>kryādi</td>
<td>69</td>
<td>70</td>
<td>71</td>
<td>66</td>
<td>38</td>
</tr>
<tr>
<td>curādi</td>
<td>418</td>
<td>419</td>
<td>426</td>
<td>1</td>
<td>260</td>
</tr>
</tbody>
</table>

Table 3

Only 1138(35%) entries from the four Dhātuītīs matched with respect to three fields viz. the root, its meaning and gana it belongs to. This includes 260 roots from curādi gana which are common to three Dhātuītīs excluding Śābdikabharanam. The low percentage of common elements is a serious concern and thus it is further necessary to probe for the nature of differences. 2065 entries differed in one or more aspects, such as

1. Different root forms
   Most of the differences in root form are due to short-long vowel variation, or similarity in the sound of phonemes or orthographic similarity. For example pṛci; pṛci, vṛjī, vṛjī, muṣa; muṣa, gu; gū, kṛ; kṛ, nṛ; nṛ show short-long vowel variations. Examples of similar sounding phonems and/or orthographic similarities are rūsa; rūsa, hīḍa; hīḍa, bhī; bhī, balha; balha, khaca; khaca, svhur; svhur, jeha; jeha, sēr; sēr.
   Pulsule treats all these verb entries as separate.

2. Different meanings
   Majority of differences in the meaning attribute to the similar sounding phonems and/or orthographic similarity. Some of the examples are ṛapravane; ṛapravane, sevane; sevane, bhasaṇe; bhasaṇe, mraksane; mraksane, mlaksane.

3. Different gana
   Approximately 10% differences are due to gana differences.

We give below some example entries of various differences.
Roots not present in all the vr̥ttis

<table>
<thead>
<tr>
<th>gana</th>
<th>Root</th>
<th>Meaning</th>
<th>MD</th>
<th>KT</th>
<th>DP</th>
<th>SB</th>
</tr>
</thead>
<tbody>
<tr>
<td>adādi</td>
<td>aji</td>
<td>varjane</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>✓</td>
</tr>
<tr>
<td>adādi</td>
<td>śāsti</td>
<td>šāsanē</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>✓</td>
</tr>
<tr>
<td>adādi</td>
<td>nisi</td>
<td>gatau</td>
<td>-</td>
<td>-</td>
<td>✓</td>
<td>-</td>
</tr>
<tr>
<td>adādi</td>
<td>nisi</td>
<td>niśāne</td>
<td>-</td>
<td>-</td>
<td>✓</td>
<td>-</td>
</tr>
<tr>
<td>kryādi</td>
<td>pus̱/puṣa</td>
<td>pāraṇe/snehanē</td>
<td>-</td>
<td>-</td>
<td>✓</td>
<td>-</td>
</tr>
<tr>
<td>juhotyādi</td>
<td>gr</td>
<td>kṣānane/diptau</td>
<td>-</td>
<td>-</td>
<td>✓</td>
<td>-</td>
</tr>
<tr>
<td>tanādi</td>
<td>ṛṇu</td>
<td>diptau</td>
<td>-</td>
<td>-</td>
<td>✓</td>
<td>-</td>
</tr>
<tr>
<td>svādi</td>
<td>ṛi</td>
<td>hiṃsāyām</td>
<td>✓</td>
<td>-</td>
<td>✓</td>
<td>-</td>
</tr>
</tbody>
</table>

Table 4

Variations in the phonological form of root as well as meaning

<table>
<thead>
<tr>
<th>gana</th>
<th>MD</th>
<th>KT</th>
<th>DP</th>
<th>SB</th>
</tr>
</thead>
<tbody>
<tr>
<td>adādi</td>
<td>prc, samparcane</td>
<td>prc, samparke</td>
<td>prc, samparke</td>
<td>prc, samparke</td>
</tr>
<tr>
<td>adādi</td>
<td>sasa, svapne</td>
<td>sasa, svapne</td>
<td>sasa, svapne</td>
<td>sasa, svapne</td>
</tr>
</tbody>
</table>

Table 5

Variations in meaning

<table>
<thead>
<tr>
<th>gana</th>
<th>MD</th>
<th>KT</th>
<th>DP</th>
<th>SB</th>
</tr>
</thead>
<tbody>
<tr>
<td>adādi</td>
<td>kasi, šāsanē</td>
<td>kasi, šāsanē</td>
<td>kasi, niśāne</td>
<td>kasi, šāsanē</td>
</tr>
<tr>
<td>adādi</td>
<td>ḍhiha, upacaye</td>
<td>ḍhiha, upacaye</td>
<td>ḍhiha, upatāpe</td>
<td>ḍhiha, upacaye</td>
</tr>
<tr>
<td>kryādi</td>
<td>bhrī, bhaye</td>
<td>bhrī, bharāne</td>
<td>bhrī, bharāne</td>
<td>bhrī, bhaye</td>
</tr>
</tbody>
</table>

Table 6

Verbs classified into different ganaś by different vr̥ttikāras

<table>
<thead>
<tr>
<th>Root</th>
<th>Meaning</th>
<th>MD</th>
<th>KT</th>
<th>DP</th>
<th>SB</th>
</tr>
</thead>
<tbody>
<tr>
<td>isā</td>
<td>gatau</td>
<td>bhvādi</td>
<td>bhvādi</td>
<td>bhvādi</td>
<td>divādi</td>
</tr>
<tr>
<td>garda</td>
<td>sabde</td>
<td>bhvādi</td>
<td>bhvādi/curādi</td>
<td>bhvādi</td>
<td>-</td>
</tr>
</tbody>
</table>

Table 7

6 Conclusion

Earlier efforts of preparing the concordances of Dhātuṛttiś have brought to the surface the differences among them. However, no quantitative account of these differences was available so far. In this paper we tried to give a quantitative measure of various differences and also enumerated the nature of various differences. In addition, by postulating a canonical form for verbal root and its meaning, we could accomplish electronic linking of these resources. Our purpose here is not to reconstruct Pāṇiniṇ Dhātrapatha, but to provide a sound database for research. What concerns us here is the large variations among different versions. The overlap is only 35%. Such a linking will help one to study the variations from linguistic perspective. With the
availability of electronic corpus classified chronologically, and the search engine, now it should be possible to study the distribution of possible root forms. However, to comment on the associated meanings, one needs semantically tagged corpus. E-linked Dhātuṣṭīs are available with a suitable interface at http://sanskrit.uohyd.ernet.in/scl/dhaatupatha.

Dhātapātha contains only basic roots, and not the roots derived by adding prefixes. Occurrence of prefixed verbs is very common in Sanskrit literature and Dhātuṣṭīs do not talk about them. Addition of prefixes not only change the verbal root but also its meaning and the pada information. And therefore in addition to linking the Dhātuṣṭīs it is also necessary to prepare an exhaustive index of verbal roots with all possible prefixes for each one of these roots.

7 Acknowledgement

Scharf’s work on Mādhaviyā Dhātuṣṭī provided the basic insight for this work. Authors thank Karunakar for the programming assistance, Devanand Shukl for helping in designing the mark-up, and Acharya Anand Prakash ji for valuable discussions on the Pāṇinian process of generation of verb conjugations.

References