

Comparison of Pāṇinīya *Dhātuvṛttis*

N Shailaja and Amba Kulkarni

Department of Sanskrit Studies,
University of Hyderabad,
Hyderabad
shailajanakkawar@gmail.com, apksh@uohyd.ernet.in

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: Pāṇinīya 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 *sārvadhātuka lakāras*. For example the verbs from *divādi gaṇa* take *śyan* suffix before a *tiñ* 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 dvitaḥ ktriḥ* (P3.3.88) allows a ‘*ktri*’ suffix only in case of verbs with ‘*ḍu*’ as a marker, such as ‘*ḍukṛñ, ḍupacaṣ*’ etc.. The accents as well as the marker ‘*ñ*’¹ indicate a set of terminal suffixes (viz. *ātmanepadī* or *parasmaipadī* 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 nāñceḥ pūjāyām* (P6.4.30) prohibits the elision of penultimate ‘*n*’ generated in the process of derivation of verbal conjugations of the root *añc*, 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 *anudāttañita ātmanepadam* (P1.3.12)

between the information coded with the verb roots in a *Dhātupāṭha* and the *Aṣṭādhyāyī sūtra 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 *vṛttis* 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 *gaṇa* and *padī* 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 *Dhātupāṭha* and the *sūtras* used for generation of verbal conjugations. Hence the purpose of having a concordance of *Dhātupāṭhas* 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 *Dhātuvṛttis*

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

1. *Mādhavīya* (Gupta, 1991),
2. *Kṣīratarāṅgiṇī* (Mīmāṃsakaḥ, 2005),
3. *Dhātupradīpa* (Mīmāṃsakaḥ, 1986), and
4. *Śābdikābharaṇam* (śukla, 2010).

Roughly all these *vṛttis* belong to twelfth to fourteenth century. *Mādhavīya Dhātuvṛtti* is written by Sāyaṇa, who belonged to late fourteenth century and was with the Vijayanagara emperors Harihara and Bukka. Kṣīrasvāmin of Kṣīratarāṅgiṇī is considered to be from the early twelfth century from Kashmir region. *Dhātupradīpa* is written by Maitreyarakṣitaḥ, a Bengali scholar from the late twelfth century. *Śābdikābharaṇam*, by Hariyogī, is also probably from the late twelfth century.

Scholars are aware that the *Dhātus* listed in various *Dhātuvṛttis* differ from each other and also from what Pāṇini had taught. For example, Brahmadata Jijñāsu(1979) under the commentary on the *sūtra upadeśe'ajanunāsika 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.

Dhātus listed in the above *Dhātuvṛttis* 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 *Mādhavīya 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 *Aṣṭādhyāyī*. 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 ‘ṇ’ as in ‘ṣvada’.
 - (b) dental stops following initial retroflex ‘s’ as in ‘ṣtak’.
 - (c) dental ‘n’ instead of homo-organic nasal as in ‘anc’.
 - (d) dental ‘n’ instead of *anunāsika* as in ‘danśa’.
 - (e) penultimate dental sibilant *s* as in ‘vrasc’.
 - (f) penultimate dental ‘d’ as in ‘add’.
 - (g) No penultimate ‘c’ before ‘ch’ as opposed to ‘pracch’.

There are rules in *Aṣṭādhyāyī* 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 *vṛttikāras* 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 *pūjane*. Sometimes the word ‘*artha*’ is used as in *gatyārthe*. Similarly we found variations among *vṛttikāras* in the use of *kṛt* suffix to indicate an activity. Some *vṛttis* used *ghañ* 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 *Dhātuvṛttis*.

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
9. *Kārikās*.

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 *Dhātuvṛttis*

Each entry in the *Dhātuvṛtti* contains one or more roots with one or more meanings associated with it. Since the *Dhātuvṛttis* 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 *Dhātuvṛtti* with m roots v_1, v_2, \dots, v_m with n possible meanings m_1, m_2, \dots, m_n then the entry is expanded into $m \cdot n$ distinct (verb, meaning) pairs.

For example an entry such as

gādhṛḥ pratiṣṭhālīpsāyoḥ granthe ca

is expanded into three entries viz.

gādhṛḥ pratiṣṭhāyām,
gādhṛḥ lipsāyām, and
gādhṛḥ granthe.

Table 1 shows the number of entries in each *Dhātuvṛtti* before and after this expansion. *Śābdikābharāṇam* 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.

<i>Dhātuvṛtti</i>	Distinct roots	Distinct root-meaning pairs
<i>Mādhavīya</i> (MD)	1890	2227
<i>Kṣīratarāṅgīṇī</i> (KT)	1885	2215
<i>Dhātupradīpa</i> (DP)	1952	2322
<i>Śābdikābharāṇam</i> (SB)	1157	1407

Table 1

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

Distribution of roots in different *gaṇas*

<i>gaṇa</i>	MD	KT	DP	SB
<i>bhvādi</i>	978	995	1031	689
<i>adādi</i>	72	69	72	71
<i>juhotyādi</i>	24	25	26	18
<i>divādi</i>	136	134	139	127
<i>svādi</i>	29	29	31	25
<i>tudādi</i>	157	159	168	132
<i>rudhādi</i>	25	25	25	26
<i>tanādi</i>	10	9	10	9
<i>kryādi</i>	60	60	64	59
<i>curādi</i>	399	381	386	1

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 *Dhātuvṛttis*. 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 *gaṇas*

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

Table 3

Only 1138(35%) entries from the four *Dhātuvṛttis* matched with respect to three fields viz. the root, its meaning and *gaṇa* it belongs to. This includes 260 roots from *curādi gaṇa* which are common to three *Dhātuvṛttis* excluding *Śābdikābharaṇam*. 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*; *pṛcī*, *vṛjī*; *vṛjī*, *muṣa*; *mūṣa*, *gu*; *gū*, *kṛ*; *kṛ*, *nṛ*; *nṛ* show short-long vowel variations. Examples of similar sounding phonemes and/or orthographic similarities are *ruśa*; *ruṣa*, *hlāda*; *hrāda*, *blī*; *vlī*, *valha*; *balha*, *khaca*; *khava*, *sphur*; *sphul*, *jehū*; *jehr*, *ṣvr*; *ṣebr*.

Palsule treats all these verb entries as separate.

2. Different meanings

Majority of differences in the meaning attribute to the similar sounding phonemes and/or orthographic similarity. Some of the examples are *āpravane*; *āplavane*, *sevane*; *secane*, *bhaṣane*; *bhāṣane*, *mraṣane*; *mlaṣane*.

3. Different *gaṇas*

Approximately 10% differences are due to *gaṇa* differences.

We give below some example entries of various differences.

Roots not present in all the *vṛttis*

<i>gaṇa</i>	Root	Meaning	MD	KT	DP	SB
<i>adādi</i>	<i>aji</i>	<i>varjane</i>	-	-	-	✓
<i>adādi</i>	<i>śāsti</i>	<i>śāsane</i>	-	-	-	✓
<i>adādi</i>	<i>ṇisi</i>	<i>gatau</i>	-	-	✓	-
<i>adādi</i>	<i>ṇisi</i>	<i>niśāne</i>	-	-	✓	-
<i>kryādi</i>	<i>puṣu/pluṣu</i>	<i>pūraṇe/snehane</i>	-	-	-	✓
<i>juhotyādi</i>	<i>gr̥</i>	<i>kṣaraṇe/dīptau</i>	-	-	✓	-
<i>tanādi</i>	<i>ṛṇu</i>	<i>dīptau</i>	-	-	✓	-
<i>svādi</i>	<i>ri</i>	<i>himsāyām</i>	✓	-	✓	-

Table 4

Variations in the phonological form of root as well as meaning

<i>gaṇa</i>	MD	KT	DP	SB
<i>adādi</i>	<i>pr̥cī</i> , <i>samparane</i>	<i>pr̥cī</i> , <i>samparke</i>	<i>pr̥jī</i> , <i>samparke</i>	<i>pr̥cī</i> , <i>samparke</i>
<i>adādi</i>	<i>śasa</i> , <i>svapne</i>	<i>śasa</i> , <i>svapne</i>	<i>śasa</i> , <i>ṣvapne</i>	<i>sasa</i> , <i>svapne</i>

Table 5

Variations in meaning

<i>gaṇa</i>	MD	KT	DP	SB
<i>adādi</i>	<i>kasi</i> , <i>śāsane</i>	<i>kasi</i> , <i>śāsane</i>	<i>kasi</i> , <i>niśāne</i>	<i>kasi</i> , <i>śāsane</i>
<i>adādi</i>	<i>diha</i> , <i>upacaye</i>	<i>diha</i> , <i>upacaye</i>	<i>diha</i> , <i>upatāpe</i>	<i>diha</i> , <i>upacaye</i>
<i>kryādi</i>	<i>bhrī</i> , <i>bhaye</i>	<i>bhrī</i> , <i>bharaṇe</i>	<i>bhrī</i> , <i>bharaṇe</i>	<i>bhrī</i> , <i>bhaye</i>

Table 6

Verbs classified into different *gaṇas* by different *vṛttikāras*

Root	Meaning	MD	KT	DP	SB
<i>īṣa</i>	<i>gatau</i>	<i>bhvādi</i>	<i>bhvādi</i>	<i>bhvādi</i>	<i>divādi</i>
<i>garda</i>	<i>śabde</i>	<i>bhvādi</i>	<i>bhvādi</i> / <i>curādi</i>	<i>bhvādi</i>	-

Table 7

6 Conclusion

Earlier efforts of preparing the concordances of *Dhātuvṛttis* 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 Pāṇinian *Dhātupāṭha*, 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 *Dhātuvṛttis* are available with a suitable interface at <http://sanskrit.uohyd.ernet.in/scl/dhaatupaatha>.

Dhātupāṭha contains only basic roots, and not the roots derived by adding prefixes. Occurrence of prefixed verbs is very common in Sanskrit literature and *Dhātuvṛttis* 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 *Dhātuvṛttis* it is also necessary to prepare an exhaustive index of verbal roots with all possible prefixes for each one of these roots.

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