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*Ratha: The Wonder Chariot of India*

The discovery of a wheel and its application to vehicular transport wrought a revolution in the military technology. In the annals of world history, the Sumerians were the first inventors of wheeled vehicles.<sup>1</sup> Chariots drawn by asses and oxen are also depicted in the contemporary world literature.<sup>2</sup> It is surprising but true that India had a transport system as old as its civilization. It is a well established fact of Indian history that, in India, the civilization of the 'Indus' was fully cognizant of this "world phenomenon."<sup>3</sup> The development of wheeled technology influenced the political, social, economic and military matters both in the world and in India. The present study deals only with the military aspects of this wonder vehicle throughout the ages. Even though most of India's military history, institutions, systems and technology are shrouded in mystery, yet we can glean some semblance of a connected chronicle from the epics and various other literary sources. The discoveries made in North India reveal that there was proper technological advancement in wheeled technology and the problems connected with it were not unknown to the Indian people. We have ample historical data to justify that it was a well established science which was well practised, too.

<sup>1</sup> V.G. Childe, *New Light on the Most Ancient East*, London 1952, p. 232.

<sup>2</sup> S. Piggot, *Prehistoric India*, Harmondsworth 1950, p.274.

<sup>3</sup> Sir John Marshall and others, *Mohenjodaro and the Indus Civilization*, London 1931, Vol. II, p. 554, pls. CXXXI, 38; CLIV 7, 10, 11; M.S. Vats, *Excavations at Harappa*, New Delhi 1940, Vol. I, p. 451; Vol. II, Pl. CXX, 1-9; E.J.H. Mackay, *Chanhudaro Excavations 1935-36*, New Haven 1943, Pl. LVIII.

## I

The gradual emergence of war vehicles as an efficient arm in the neighbouring countries, particularly in Persia and Babylon<sup>4</sup> attracted the attention of the Indian business community. In those days the Indian people, and in particular the business community, had close contacts<sup>5</sup> with the Sumerians and Arabs<sup>6</sup> and perhaps they brought this technology to India. Soon, the use of carts became popular among the Indian masses.<sup>7</sup> There is no doubt that the 'Indus' people used a wheeled cart for their business matter, trade and transport requirements, but we do not have any reference as to whether they had ever used it as an instrument of war, as it was used by their contemporaries.<sup>8</sup> But from the military point of view, in India, the Aryans also used chariots as an instrument of war. Under them the wheeled technology was further revised and improved, which was necessary for their contemporary requirements. The early vehicle of the Aryans was small in size, probably a two-wheeled vehicle<sup>9</sup> which was drawn by one or two horses or mules. The Aryans were well versed in the art of cart manufacturing and soon they changed the design of chariots and a new version was constructed and four-wheel style was adopted. The body of the chariot now appears to have been exceedingly light, consisting of a wooden framework, fixed on an axle known as *akṣa*.<sup>10</sup> They also invented spokes, had done away with two of the four wheels, and substituted the horse for the ass and mule.<sup>11</sup> It is interesting to note that the Aryans were also specialized in the art of horse-breeding, which was not known to their enemies.<sup>12</sup> That is why their chariots proved superior, and the chariot thus improved, posed a threat to the defence and security of their contemporaries. It has been pointed out by O.R. Gurney that the Aryans

<sup>4</sup> Mackay, op. cit. Cf. the Mesopotamian toy carts illustrated in Armas Salonen's *Die Landfahrzeuge des Alten Mesopotamien*, Pls. X, XI, XV. etc., *Hippologica Accadica*, Helsinki 1956, pls. XI, XV and Vats, op. cit., II, pl. CXXV, 35 also Richard Aldington and Delano Ames, *Larousse Encyclopedia of Mythology*, London 1959, pls. facing pp. 96, 101, 108, 115, 153, 158, 203, 343, 345, 368, 384.

<sup>5</sup> Childe, op. cit., pp. 162-170.

<sup>6</sup> Marshall, op. cit., p. 554.

<sup>7</sup> Vats, op. cit., II pl. CXXV, 35.

<sup>8</sup> Sarva Daman Singh, *Ancient Indian Warfare with Special reference to the Vedic Period*, Leiden 1965, p. 24.

<sup>9</sup> *R̥gveda*, Ed. Sātavalekar, Śrīpāda Śarmā Dāmodara, Duth 1940, VIII, 5, 29. Henceforth: *R̥gveda*; *Chāndogya Upaniṣad*, *Ānandāśrama Sanskrit Series*, Poona 1902, IV, 16.5; *Talavakāra-Upaniṣad-Brāhmaṇa*, Ed. Radhakrishnan, Sarvāpalli, London 1953, III, 16.7 also *Kauṣītaki-Upaniṣad*, 1.4.

<sup>10</sup> *akṣa*, i.e. axle made of *araṭu* wood is mentioned in *R̥gveda* VIII, 46.27; H. Zimmer, *Altindisches Leben*, Berlin 1879, p. 247, n.; *R̥gveda* VIII, 5.29.

<sup>11</sup> Singh, op. cit., p. 25.

<sup>12</sup> O.R. Gurney, *The Hittites*, p. 105.



while moving westward brought with them special knowledge of horse-breeding, and that it was from them that the art was learnt by the people of Western Asia.<sup>13</sup> In India they too remained superior, as reflected in the hymn of the *R̥gveda*.<sup>14</sup> In the *R̥gveda*,<sup>15</sup> numberless verses sing the glories of the chariot and mention its various parts. Indeed, the descriptions are detailed almost to a rault, the origin of the epics, *Rāmāyaṇa* and the *Mahābhārata* may be mythical but when critically studied against the background of that age, they give an insight into the various parts of *ratha*, and we can reconstruct from them a fairly trustworthy picture of the contemporary chariots.<sup>16</sup>

The *R̥gvedic* chariot, called *ratha*, was a two-wheeled vehicle. Stuart Piggott<sup>17</sup> informed us that *ratha* is an Indo-European word for 'wheel', utterly, the words for axle, nave and yoke are likewise common to the whole language group. According to Padamachandra Kōśa,<sup>18</sup> *ratha* means a kind of vehicle which was used for travelling.

According to *R̥gveda*,<sup>19</sup> the contemporary chariots were of different types. The *Śulbasūtra* of Āpastamba,<sup>20</sup> a text of late date, specifies the dimensions of the chariot as 188 *aṅgulis* for the pole, 104 for the axle and 86 for the yoke. Generally, the Indian chariots had two wheels, whereas a chariot used in Sumer had four wheels and was drawn by a pair of animals and was ridden by two men; one of them drove the animals while the other was the warrior who hurled spears on the enemies.<sup>21</sup>

In India preference was always given to the two-wheeled vehicles.<sup>22</sup> The wheels of vehicles of the Aryans were round and had wooden nails in the middle, known as *ara*.<sup>23</sup> The axle, according to Piggott,<sup>24</sup> was fixed centrally to the chariot floor. There used to be wooden spokes between the two wheels. As stated earlier, it was known as *akṣa*.<sup>25</sup> The wheels were fixed to the ends of the axle projecting free of the vehicles body on each side, and secured by linch-pins, sometimes accepted as *aṇi*.<sup>26</sup>

<sup>13</sup> Ibid., p.105.

<sup>14</sup> *R̥gveda*, I. 53.9.

<sup>15</sup> Ibid., X. 1.5, X. 85.14; I. 34.2; I. 183.2.

<sup>16</sup> Cf. Singh, op.cit., p. 26.

<sup>17</sup> Cf. Piggott, op. cit. p. 216.

<sup>18</sup> Gaṇeś Datta Śāstrī, Padmachandra Kōśa, *An Etymological Sanskrit Dictionary*, Lahore 1940, p.402.

<sup>19</sup> *R̥gveda*, X. 1.6.

<sup>20</sup> Ibid., VI.5.

<sup>21</sup> Singh, op. cit., pp. 24–25.

<sup>22</sup> Cf. Ravindra Kumar Sharmā, *Vedic Kālin Sainya Vyavasthā*, "Anusandhana Journal of Indology," Ladanu, Rajasthan, Vol. II, April 1973, pp. 56–59.

<sup>23</sup> *R̥gveda*, V. 13.6; V. 58.6.

<sup>24</sup> Piggott, Loc. cit., p. 277.

<sup>25</sup> *R̥gveda*, X. 85.8.

<sup>26</sup> Cf. Singh, op. cit., p.27, n. 6.

on their outer faces. The wheels had metal tyres, besides a felly, known as *pradhi*<sup>27</sup> and *ara*<sup>28</sup> known as *nābhya*.<sup>29</sup> The rim and the felly together were called *nemi*.<sup>30</sup> The hole in the nave was called *kha*.<sup>31</sup>

It is pointed out by Sarva Daman Singh<sup>32</sup> that the Vedic chariot wheel seems to have had four to eight spokes. The felly of the wheel might have been occasionally a single piece bent into circular shape, as attested by a Ṛgvedic simile, thus it can be presumed that the Vedic chariot must have required more than four spokes.<sup>33</sup>

A central pole projected forwards from the bottom of the chariot, and it was passed through a hole (known as *kha* or *tardman*) in the yoke. This pole rose at an angle with the chariot floor, usually in the form of a curve, but perhaps sometimes also of a straight line. A stout pin known as *śamyā*<sup>34</sup> or bolt was provided through the chariot pole, against which the yoke was tied with straps of leather. The yoke, better known as *yuga*,<sup>35</sup> was laid across the necks of the horses on either side of the pole. Macdonell and Keith<sup>36</sup> are of the opinion that the horses were put between the vertical angle, the yoke was adjusted accordingly. According to Macdonell and Keith, the yoke was put on the shoulders of the horses and a wooden pillar was used for this, which was sometimes tied by the neck and at the back of the horse with the help of traces.<sup>37</sup>

Generally one or two horses were used in one chariot. But we also find a description of three or four horses which shows the status of the owner.<sup>38</sup> Those who could not afford more, used only one horse. During the period under reference the horses must have been yoked abreast though occasionally an extra horse might have been placed in front. The practice of yoking horses abreast front would wield a greater projectile force, and if horses were used one behind the other, an injured horse in front would impede the progress of those behind. Therefore a two-wheeled chariot with one or two horses was always preferred.<sup>39</sup>

<sup>27</sup> P.C. Chakravarti, *The Art of War in Ancient India*, Dacca 1941, p. 28.

<sup>28</sup> Cf. Śāstri, Indirā Caran, *Ṛgvedik Rathārōhi Senā*, "Sammelan Patrika," Hindustāni Akādemī, Allāhabād, Vol. LVIII No. I, p. 99.

<sup>29</sup> Rām Kumār Rai, *Vedic Index*, Cal 1928, Vol. II, p. 201.

<sup>30</sup> *Vedic Index*, op. cit. Vol. II, p. 201.

<sup>31</sup> *Ṛgveda*, VIII, 91.7.

<sup>32</sup> Cf. Singh, op. cit., p. 27.

<sup>33</sup> *Ṛgveda*, VII. 32.20 "nemin tasteva sudrvam."

<sup>34</sup> *Ṛgveda*, III 6.6.

<sup>35</sup> Singh, op. cit., p. 28.

<sup>36</sup> *Vedic Index*, op. cit., II, p. 224.

<sup>37</sup> Ibid., p. 224.

<sup>38</sup> *Udyoga Parvan*, ed. S.K. De, Poona 1940, 155, 13 ff.

<sup>39</sup> Cf. "The Journal of the American Oriental Society," Vol. VIII, p. 251.

Piggott<sup>40</sup> actually gives a hypothetical figure of the Ṛgvedic chariot built on a U-shaped plan. Two cave<sup>41</sup> illustrations of chariots of Morhana Pahār in Mirzāpur District record, according to Mrs. Allchin,<sup>42</sup> the reminiscence of a sortie in the early centuries B.C. from some centre in the Gangā-Yamunā Doāb in the territory of hunting tribes who still used no metal. One of these chariots is drawn by two and the other by four horses. They look like two-wheeled vehicles with long axles, square floors and high fronts, behind which the charioteers are standing. It is not clear whether the two circles shown on each side near the front of one of the chariots represent another pair of wheels or the sides of the vehicle shown in plan. There were rapid and frequent changes<sup>43</sup> in chariot manufacturing technology, particularly as concerns the post-Vedic chariot.<sup>44</sup> It is also depicted in the *Rāmāyaṇa*<sup>45</sup> and *Mahābhārata*<sup>46</sup> that occasionally light wheeled chariots were used and such vehicles were drawn by four horses.

This technology remained in force and unchanged for about a thousand years to come as is also supported by the Bharhut<sup>47</sup> and Sāñcī<sup>48</sup> sculptures of the ancient Indian chariot. This is reflected from the Sāñcī chariot that a two-wheeled vehicle was unanimously adopted by the Indian society.<sup>49</sup>

## II

According to *Ṛgveda*,<sup>50</sup> only efficient, patient and expert artisans should enter, the profession because the manufacturing trade was full of skill and art and required a lot of patience and knowledge. Therefore, it can be presumed that the art was accepted as a respectable trade which also attracted higher and learned gentry of the Indian society. Two Ṛgvedic verses<sup>51</sup> refer to the Bhṛguś as chariot-builders. In due

<sup>40</sup> Piggott, op. cit., p. 280, fig. 32.

<sup>41</sup> Singh, op. cit., p.20.

<sup>42</sup> Singh, op. cit., p.29.

<sup>43</sup> *Rāmāyaṇa*, Śrīmadvālmīkiyaṁ Rāmāyaṇaṁ, Rāmābhinandinī bhāṣātīkāsa-hitam, Paṇḍit Pustakālaya, Kāśī 1951, Laṅkāparvan 44.27; The Droṇaparvan, ed. S.K. De, Poona 1953-58, 165. 38.

<sup>44</sup> Indika, Fragm.XXXIV, quoted by R.K. Mookerji, *Chandragupta Maurya and his times*, Madras 1943, pp. 168-71.

<sup>45</sup> *Rāmāyaṇa*, op. cit., Lanka 44. 27.

<sup>46</sup> *Mahābhārata*: Bāṇaparvan, 308.11. Calcutta 1926-27.

<sup>47</sup> Sir Alexander Cunningham, *The Stūpa of Bharhut*, London 1879, Pls. XIII, XXV, 4.

<sup>48</sup> Sir John Marshall, and A. Foucher, *The Monuments of Sāñcī*, Calcutta n.d., Vol. II, pls. XI, middle lintel; XV, bottom lintel; XXIIIa, etc.

<sup>49</sup> JAOS, Vol. XIII, p. 251.

<sup>50</sup> Śāstri, op. cit., p. 99.

<sup>51</sup> *Ṛgveda*, IV 16.20; X. 39.14.



course, more or less people from the middle class formed the majority of the community. The latter, known as *rathākāras*,<sup>52</sup> appear as a functional cast as early as the *Atharva-Veda*.<sup>53</sup> The *Atharva-* and *Yajur-Veda-Saṁhitās*<sup>54</sup> mention the *rathākāra* as the representative of an important class of industrial population. But, unfortunately, in *Mahābhārata* the position of the *sūta* community was considered lower than that of kings and knights.<sup>55</sup> The example of Karna is noteworthy in this regard. However, it is interesting to note that the reverse of the coin was absolutely different from the face as we have plenty of references where kings and knights considered it a matter of pride to act as charioteers<sup>56</sup> for their fellow colleagues. The name of Lord Kṛṣṇa, Śalya, Pradyumna and Uttara are mentioned in this context in the *Mahābhārata* (in *Virāṭaparva*) and shows the importance of this profession<sup>57</sup> and community.

### III

Each chariot carried a warrior and his driver, called *savyeṣṭhā* or *savyaṣṭhā* and *sārathi* or *sthātr*, respectively.<sup>58</sup> These two persons are also discussed in detail by the later *Saṁhitās*. It is shown in the *Atharvavedasaṁhitā*<sup>59</sup> that the *saṁgrahitr*, *sārathi* wore a turban, an ornament called *niṣka*, a garland called *sraja* with the upper part of his body naked, and probably carried no weapon, references were also made in VS. XXX.II, which, according to Sāyaṇa was an attendant to the charioteer and was

<sup>52</sup> Singh, op. cit., p. 34.

<sup>53</sup> Cf. *Atharva-Veda-Saṁhitā*, herausgegeben von R. Roth, and W.D. Whitney... Zweite verbesserte Auflage besorgt von Dr. Max Lindenu, Berlin 1924. Translated with a critical commentary by W.D. Whitney, revised and edited by Lannan, C.R., Hos., vols. VII and VIII, Cambridge 1905; also the *Hymns of the Atharva Veda*, Dr. R.T.H. Griffith, Benares 1916–17. See *Atharva-Veda*, III. 5.6.

<sup>54</sup> *Atharva-Veda* III. 5.6. Herausgegeben von Leopold von Schroeder. 3 Bde und Wort-Index von Richard Simon Leipzig 1900–1912; *Kāṭhakam* (Henceforth *Kāṭhaka-Saṁhitā*) XVII, 13; herausgegeben von Dr. Leopold von Schroeder, *Maitrāyaṇi-Saṁhitā*, Leipzig 1881–1886, vol. II, 9.5; Mahesachandra Nyāyaratna, *Taittirīya-Saṁhitā*, Calcutta 1860–1899. Vol. IV and VI spl. 5.4.2; *Vajasaneyi-Saṁhitā*, Ed. Śripada Śarma Satavalekar, Dāmodara, Oundh, Vikram Samvat 2003, XVI 17 XXX.6; *Śatapatha-Brāhmaṇa*, Ed. A. Weber, Berlin–London 1855, vol. VIII, 4.2.17.

<sup>55</sup> Cf. *Mahābhārata*, 5.48.28, 8.23, Iff., 8.25.I.2.

<sup>56</sup> Cf. Lord Kṛṣṇa, Śalya and Prince Uttara's role in the war of *Mahābhārata*, see *Mahābhārata*, I. 213. 33, 2.47. 21, 5.152 II, 8.22. 52. FF.

<sup>57</sup> *Mahābhārata*, 3. 20.5.

<sup>58</sup> *Rgveda*, II.12.8; *Taittirīya-Saṁhitā*, I. 7.9.1 and *Atharva-Veda*, VIII, 8.23.

<sup>59</sup> *Atharva-Veda*, VIII. 8.23, III. 21.3.

known as *anukṣattr*.<sup>60</sup> It is relevant to note here that the *Vrātya* hymn of the *Atharvaveda*<sup>61</sup> speaks of two forerunners and two footmen called *purahsarau* and *pariškanda*, respectively. *Pariškanda* used to run beside a chariot. Further the *Abhayarājakumārasutta*<sup>62</sup> informs that an efficient charioteer must be familiar with the various parts of the chariot. The *Vinaya*<sup>63</sup> tells us that a war-car has four men, two of them might be armed foot-soldiers looking after each wheel, while the warrior and the driver occupy the chariot. Four men in a vehicle would make free movement impossible. Generally the chariots were arrayed on one side at the massing of the army.<sup>64</sup>

The chariots are usually adorned with rows of jingling bells and have a covering against the sun called *ātapatra*.<sup>65</sup>

The chariots of commander always carried an umbrella, called *chattra*<sup>66</sup> with a *dhvajayaṣṭi* ensigned of race or state motto.

The favourite emblems incorporated in the *Mahābhārata*, are a golden altar decked with a water pot, a figure of a bow, elephants, lions, *garuḍa*, *mṛdangas*, etc.<sup>67</sup> The use of clan banner on their chariot was restricted to kings and princes. The banner was always furled on every vehicle in time of war. The word *dhvaja* occurs twice in the *Rgveda*.<sup>68</sup> Generally the Vedic banners appear to have been rectangular in shape and always ensigned by clan motto. The incharge of each carrier carries<sup>69</sup> his own coach besides a standard of the clan. Here it is relevant to note that the standard was not a personal flag but it was used to mark the position within an army of a body of men commanded by a *rājanya*. It was never furled during a campaign but was used at the head of the force travelling his vehicle, when on the march.

<sup>60</sup> *Vājasaneyi-Saṁhitā*, Ed. Satavalikar Damodara, Oundh, Vikrama S. 2003 Tr. R.T.H. Griffith, II edn., Benares 1927, XXX.73; *Taittiriya-Brāhmaṇa*, Anandaśrama Sanskrit Series, No. 37, Poona 1898, vol. III, 4.9.1.

<sup>61</sup> *Atharva-Veda*, XV 2.1.

<sup>62</sup> *Majjhima-Nikāya*, Ed. V. Trenckner and Lord Chalmers PTS. London 1898–1899. Tr. I.B. Horner, The Collection of the Middle Length PTS. London 1954–59, vol. I, p. 395.

<sup>63</sup> *Vinaya-Piṭaka*, Ed. H. Oldenberg, London 1879–83, Tr. I.B. Horner, *The Book of the Discipline*, London 1938–52, vol. IV, 105.

<sup>64</sup> *Ibid.*, vol. IV, 107, 108.

<sup>65</sup> *Mahābhārata*, I. 212.3. I. 213. 41; 2.22. 17; 2.54.4.

<sup>66</sup> E.W. Hopkins, *The Social and Military Position of the Ruling Caste in Ancient India as Represented by the Sanskrit Epic*, JAOS 13, 1889, pp. 235–36.

<sup>67</sup> *Mahābhārata*, I. 216. 12; I. 216.8; I. 216.14; 15; 6.17 18; 6.17.24; 6.17.21. etc.

<sup>68</sup> *Rgveda*, VII 85.2; X 103.11.

<sup>69</sup> Adolf Kalgi, *The Life in Ancient India*, Tr. Arrow Smith, Calcutta 1950, pp. 19-20.

The other important parts of the chariot, frequently mentioned, are the *rathanīḍa*<sup>70</sup> and the *rathopastha*.<sup>71</sup> The *upastha*, according to Hopkins, denoted the general bottom of the car, while the *nīḍa* meant the little shelf in front, where the charioteer stood.<sup>72</sup> The body of the car appears to have been exceedingly light, consisting of a wooden framework fixed on a required axle. *Vandhura* and *talpa*<sup>73</sup> seem to denote according to Hopkins, seats for the driver and the warriors.<sup>74</sup> From there, the driver controlled the horses by the reins, and urged them on with a whip which was known as *kaśā*. The girths of the horse were called *kakṣya*.<sup>75</sup> The word *varutha* (made of iron), a guard or protection, must signify the fence, presumably of leather, round the body of the chariot.<sup>76</sup> Gold, silver and copper cloths were used for the chariots. But the meaning and purpose of the *triveṇu* or the threefold piece is not clear.<sup>77</sup> Horses were well protected and caparisoned with armour and nets. Iron, bronze, gold, silver, leather robes, wooden breastplates were used for the purpose.<sup>78</sup> The horses were also decorated with ornament and were duly caparisoned during the time of war. Horses of different colours were used in Indian chariots. Their favourite colours were white, red, *tittiri*, *kalmāṣa* and brown.<sup>79</sup> For Indian chariots, horses were also imported. Horses from far and near were brought for sale by the traders. The famous breed of horses were Kambōja, Sindhū, Gurjara, Kalinga, etc.

#### IV

It is the charioteer's prime duty to protect the *yōdhā* in his vehicle, whereas the warrior should do everything he can to guard the life of his driver. The true art of the charioteer lies in driving it fast and straight, wheeling and turning rapidly about, so that the chariot faces every direction at once.<sup>80</sup> He was also supposed to be well versed in the art of *maṇḍala* and *yamaka*.<sup>81</sup> Sometimes during peace negotiations, he also acted as the ambassador of his leader.<sup>82</sup> Their functions in war are thus

<sup>70</sup> *Mahābhārata*, 6.23. 12; 3.15.20; 6.1.18; 8.7.13.

<sup>71</sup> *Ibid.*, 6.49. 26; 6.67. 30; 6.54.16.

<sup>72</sup> Hopkins, op. cit., p. 238.

<sup>73</sup> *Mahābhārata*, 3.230.30; 3.231.5.

<sup>74</sup> Hopkins, op. cit., p. 239 n.

<sup>75</sup> *Vedic Index*, II.202.

<sup>76</sup> *Mahābhārata*, 7.42.5.

<sup>77</sup> *Ibid.*, 3.231.5.

<sup>78</sup> Cf. Ravindra Kumār Sharmā, *Vedic Kālin Saṁya Vayavasthā* op. cit., p. 57.

<sup>79</sup> *Mahābhārata*, 3.20. 8; 2.47. 4; 2.25.19. Sharmā, *Vedic Kālin Saṁya Vayavasthā*, op. cit., p. 58.

<sup>80</sup> Singh, op. cit., p. 47.

<sup>81</sup> *Mahābhārata*, 3. 20. 8; 4.52.27; 6.48.53.

<sup>82</sup> *Ibid.* I. 1.14. FF



described by Kauṭilya. Protection of the army, repelling the attack made by all the four constituents of the enemy's army; seizing and abandoning (positions) during the time of war; restoring a broken array or phalanx, breaking the compact array of the enemy's army, frightening, inspiring awe by magnificence and sound.<sup>83</sup> According to Kauṭilya the chariot warriors must be skilled in the art of arrow shooting known as *iṣu*, and hurling clubs and cudgles, i.e. *astrapraharāṇa*.<sup>84</sup> Kauṭilya further advises the charioteers that chariots should be used on the land which is free from mounds and wet lands and which affords space for turning; according to him the chariots work best in the dry season.<sup>85</sup> Perhaps this timely advice of a learned thinker was influenced by the result of the battle of Hydaspes, which provoked his military thoughts as it is reflected in his writings.

## V

Even after the disastrous experience of Hydaspes charioteers and chariotry still remained popular with the Indian rulers. Megasthenes, while mentioning the Mauryan army, makes the reference to chariots. He pointed out that there was a separate department of the war office charged with the duty of maintaining the efficiency of the chariot as an element of the army with an incharge known as *Rathādhyakṣa*.<sup>86</sup> According to Kauṭilya, his primary duty was to look after the construction of the war chariots. The Mauryan chariots were of different sizes. Kauṭilya informed us about seven different kinds of chariots then in use. Normally, the chariots in use were ten *purushas* high and six *hastas* wide. Different versions are also available regarding chariot industries.<sup>87</sup>

During the time of king Harṣa, the Indian army was composed of infantry, cavalry elephant and chariot corps. But the non-employment of war chariots in the various campaigns of Harṣa mentioned by Bāṇabhaṭṭa and the importance attached to elephant corps and camel forces, would suggest that the chariot as one of the offensive arms of ancient India was coming to play only an insignificant role in the seventh century A.D.<sup>88</sup> But of course ceremonially they were still in use. Hiuen

<sup>83</sup> Kauṭilya's *Arthaśāstra*. Ed. R. Śhāmaśāstri, Revised Ed. Mysore 1904. X.4 See *Svabalarakṣā caturaṅgalapratīṣedhaḥ Saṁgrāme grahaṇam mokṣaṇam Chinnasa-mdhānam abhinnabhedanām trāsanam bhimaghosaśceti rathakarmāṇi*.

<sup>84</sup> Ibid., II. 33.

<sup>85</sup> Ibid. IX.I: *Toyāśayāśrayavati nirutkhātini Kedārahinā Vyāvartanasamarthiti rathānāmatisayah* and *alpavarṣapaṅkam varṣati maruprāyam*; also *Mahābhārata: Apaṅkagartarahitā rathabhūmiḥ praśayati*. See *Śānti-Parvan* XXIV.

<sup>86</sup> Radhakumud Mookerji, *Chandra Gupta Maurya and his times*, Madras University Sir William Meyer Lectures 1940–41, pp.174.5.

<sup>87</sup> P.C. Chakravarti, *The Art of War in Ancient India*, Delhi 1972, p. 31.

<sup>88</sup> Bimal Kanti Majumdar, *The Military System in India*, Calcutta 1955, pp. 88, 94–95.

Tsiang informs us that "Indian generals still rode on four-horsed chariots protected by bodyguards."<sup>89</sup> Earlier they are also mentioned in the Junāgaṛh inscription of Rudradāman A.D. 151–52.<sup>90</sup> Daulatpur plate of Bhōjadeva I (706 A.D.) also informs about their existence.<sup>91</sup> The Samnād copper-plates grant of Dantidurgā also known as Dantivarman II, dated A.D. 753–54, tells about the chariot force.<sup>92</sup>

It can be accepted that the decline of a chariot must have commenced many centuries earlier. Though they lingered on here and there. In fact, an extraordinary change can be noticed even in the description of the battle of Hydaspes. There, Porus forced by the result of the preliminary encounter of the advance guard, which Porus had sent under his son to oppose the landing of Alexander's army on this bank of the river, the chariots "proved to be of scarcely any service, for the storm of rain (which had raged during the night) had made the ground slippery and unfit for horses to ride over, while the chariot kept sticking in the muddy sloughs formed by the rain, and proved almost immovable from their weight." Yet ignoring this strategic difficulty, the drivers rode at full speed into the midst of the battle, "thinking they could thus most effectively succour their friends."<sup>93</sup> The idea was probably to use the momentum of the weight and speed of the horse and chariot as an offensive weapon. The Macedonian foot soldiers, who were exposed to first shock of the onset, were no doubt trembled down, but the Porus car-men themselves "were hurled from their seats, when the chariots rushing into action jolted over broken and slippery ground." Some of the horses took fright and precipitated the carriages not only into the sloughs and pools of water, but even into the river itself.<sup>94</sup> Even after this disaster, however, Porus had some 300 chariots left in his army. In his next move, he drew up his army in order of battle, and placed the chariots in front of the cavalry on the flanks, but he himself rode an elephant and commanded the army from elephant back. Again in the final action the chariots fared hardly better than in the preliminary skirmish. The first onset of the Macedonian cavalry threw them into confusion. Arrian says that the drivers of the chariots were all slain, and the chariots were broken to pieces.<sup>95</sup> Diordorus mentions that "the Macedonian cavalry began the action, and destroyed all the chariots of the Indians."<sup>96</sup> Again, here too, the experience of the battle of Arbela where earlier they had crushed the dreadful scythed chariots of the Persians, helped them and they won.<sup>97</sup> The fate of the battle of Hydaspes served as

<sup>89</sup> Samuel Beal, *Buddhist Records of the Western World*, London 1911, vol. I, p. 65.

<sup>90</sup> *Epigraphia Indica*, Vol. VIII, 48.

<sup>91</sup> *Ibid.*, Vol. V, 211.

<sup>92</sup> "Indian Antiquary", Vol. XI, 108, also VIII, 140.

<sup>93</sup> P.C. Chakravarti, *op. cit.*, p. 24.

<sup>94</sup> J.W. McCrindle, *India and Its Invasion by Alexander*, pp. 207-8.

<sup>95</sup> *Ibid.*, p. 107.

<sup>96</sup> *Ibid.*, p. 275.

<sup>97</sup> Sir Percy Sykes, *A History of Persia*, London 1958, Vol. I, pp. 258-9.



an eye-opener to the contemporary and later military leaders and thinkers, as it is clearly reflected in the *Arthaśāstra* of Kauṭilya<sup>98</sup> From now on the chariots were discarded as single weapons for sure success and weight was given to elephant corps.<sup>99</sup> Kauṭilya provides us with an inkling into the military thought of his age when he writes that “it is an elephant that the destruction of an enemy’s army depends on.” The victory of kings in battles, he remarks further, depends mainly upon elephants. The Nikāyas and Vinaya affirm the fourfold divisions of the army, but the chariot does not seem to be an important instrument of war as it does in the Vedic literature.<sup>100</sup> The Bauddha and Jain Literatures are also silent about their military importance.<sup>101</sup> In the course of time the chariot was also rejected as an instrument of war by the Kuṣāna rulers.<sup>102</sup> Chariots were also neglected by the Guptas and Sātayāhanā rulers.<sup>103</sup> Bāṇa and Huien Tsiang are silent about their military utility. They were not found suitable in the peculiar condition of the state of Deccan. Pulakeśin II, the lord of the land of beyond river Narmadā also discarded war vehicles and preferred elephant corps. The Chinese pilgrim who visited his court in the year 641 A.D. makes no reference to war-chariots.<sup>104</sup> Similarly, the *Gauḍavahō* of Vākpati, though it gives interesting details regarding military organisation of Yaśovarman, is characteristically silent about war-chariots.<sup>105</sup> The newly growing military powers from Kanauj and later from the Sindh also discarded them and opted for elephant corps.

## VI

Muḥammad Ibn al-Qāsim, who invaded Sindh in the early 8th century A.D., did not encounter war-chariots in any of the numerous armies with which he had to fight.

<sup>98</sup> *Arthaśāstra*, VII.2.

<sup>99</sup> *Kamandaka Nitisara*, Ed. R. Mitra, Calcutta 1884, XVI, 10-12.

<sup>100</sup> *Digha Nikāya*, ed. T.W. Rhys Davis and Estlin Carpenter, J. PTS London, 1890-11, vol. III, 200, *Majjhima Nikāya*, op. cit., 111, 173, 174, 176; *Aṅguttara Nikāya*, Ed. R. Morris and E. Hardy, London 1885-1900, vol. III, 327; *Vinayas*, op. cit. I 241, II, 10, 182; IV, 105, 107, 108.

<sup>101</sup> *Āvaśhyakachūṛṇi*, Jain, Bombay 1961, 188; *Abhigyāñchintāmani Hemchandra*, Bombay 1971, P. 300. Cf. Ravindra Kumār Sharmā *Military System in Ancient India: As reflected from the Buddhist literature*. “Journal of the Central Institute of Buddhist studies”, Laddakh Leh 1985.

<sup>102</sup> *Khotam MSS*, “Journal of the Royal Asiatic Society of Great Britain Ireland”, 1942, p. 19; “Indian Antiquary”, op. cit., 1903, p. 388.

<sup>103</sup> Gunaighar Inscriptions, Cf. “Indian Historical Quarterly”, Calcutta 1936, VI, P. 53 FF.

<sup>104</sup> Thomas Watters, *On Yuan Chwang’s Travels in India*, Ed. T.W. Rhys Davis and S.W. Bushell, Vol. II, 239.

<sup>105</sup> Chakravarti, op. cit., p. 26.



The Chach dynasty of Sindh also discarded war-chariots and opted for *chaturangbala*, i.e. infantry, cavalry, elephant and camel corps.<sup>106</sup> Following the tradition of their military predecessors, the Hindū Śāhis of Afghanistan and Punjab also relied upon elephant corps.<sup>107</sup> Meanwhile, Pālas of Bengal, Kalacuris of Trīpurī. Cālukyās of Gūjarāt. Bhāṭis of Jaisalmer, Gūhilōts of Mewār all led their armies on elephants.<sup>108</sup> During the tenure of Tomars and Cauhāns again the elephants and not the war chariots formed the most valued section of the army.<sup>109</sup> So it can be presumed that the final disappearance of chariots from India's military system probably came about in the eight century A.D. From then on they were losing their military charm and their place was gradually taken up by elephant corps. Rajput rulers, particularly the Gūrjara-Pratihāra of Kanauja, the Candelas of Jejākabhukti, the Cāhamānas of Sākambhari, Ajmer and Delhi, and finally the Gahadṽala of Kanauj and Vārāṇasī all opted for elephant corps in place of war chariot and always relied upon war elephant<sup>110</sup> instead of war chariot whenever they fought for national defence. They also put emphasis on camel corps in the desert area of Rājasthān, for geographical requirements.<sup>111</sup>

<sup>106</sup>*Chāchnāma* also known as *Tārīkh-i-Hind*, *Wa Sindhōr Fatehnāma*, Idarah-i-Adabiyat, Delhi 1971, pp. 167–80.

<sup>107</sup>Elliot and Dowson, *The History of India as told by its own Historians*, Kitab Mahal, Allahabad 1971, vol. I, p.13.

<sup>108</sup>Cf. Sharma, *Military System of the Mewar State C. 800–1947 A.D.*, "Central Asiatic Journal", Otto Harrassowitz, Wiesbaden 1984–85, pp. 60–85; *Military System of the Rājput*, Based on Ph.D. Thesis, under the supervision of Dr. K.S. Lal, Professor and Head Department of History, University of Jodhpur and the University of Hyderabad, to be published by Pragati Prakashan, Delhi.

<sup>109</sup>Mohammad Qāsim Hindushāh Ferishta (Briggs) Calcutta 1978, Vol. I p. 17; "Epigraphica Indica", Vol. XI, p. 310; *Jayānaka's Prithvirājavijaya*, ed. G.H. Ojha and Chandra Dhar Guleri, Ajmer 1941, X, 19–20, Sharmā, Dasharatha, *Early Chauhan Dynasties*, Delhi 1959, p.214; Singh, *History of the Chahamanas*, Banaras, 1964, p. 312. Cf. Sharmā *Military System of Hammira Deva of Ranthambhore*, *Proceedings of the Seminar: 700th Coronation Anniversary of Hammirs Deva Chauhan*, organised by the Hammira Research Center Government of Rajasthan, India, December 31 st, 1983.

<sup>110</sup>Cf. Ravindra Kumār Sharmā; *Rajput Elephant Corps: An Assessment*, *Cultural Contours of India*; Dr. S. Prakash Felicitation Volume, Delhi 1981, Vol. II, pp. 389–91.

<sup>111</sup>Cf. Ravindra Kumār Sharmā, *Military System of the Jodhpur State C. 1212 to 1947 A.D.*, Kurukshetra University, "Research Journal, Arts and Humanities, Kurukshetra University," Haryana 1983, Vol. XVI–XVII, pp. 117–126.

## VII

Chariots needed a dry and plain soil for their use, which was not possible in a country like India. Moreover, chariots could not be used in hilly areas or morasses, nor in the rainy season.<sup>112</sup> Chariots were too heavy and overweighted and thus could not face a fast-moving mobile army with swift riders. For military transportation they also became useless.<sup>113</sup> The speed at which an army could travel over land was greatly restricted by the wagons and the lack of roads, especially under Indian geographical conditions, and particularly in Rājasthān, north-west frontiers, hilly areas of Kaśmir and in Deccan, where frequently a breakdown in one wagon or a chart could delay the entire military movement. Moreover, they required more space for movements and effective working, which was generally impossible in the remote areas of India. There was no match between a fast-moving cavalry and a line of heavy-wheeled cars.<sup>114</sup> Chariots had also serious limitations as instruments of war against mounted cavalry consisting of Turkish bows. Again they proved a failure against mounted archers, especially in front of the soldiers having cross bows. Of course, sometimes they served well on even ground in ideal conditions, but told a pathetic tale in difficult terrain and adverse weather.<sup>115</sup>

## VIII

Though they lost importance from the military point of view, yet they continued in the economic sector of the country's economy and remained the number one mode of travelling.<sup>116</sup> The slightly revised versions of the Indian war chariots with required

<sup>112</sup>Cf. Kaṭilya, *Arthaśāstra*, op. cit., X, 4; Santi Parvan, 100, 22.

<sup>113</sup>Singh, op. cit., p. 52.

<sup>114</sup>Kamandaka, Nitisara, Ed. T. Ganpati Śāstri, XX Cf. Sharmā, *Military System of the Rājapūts: A Case Study of Rājasthān, Indian Indology: Dr. Dinesh Chandra Circar, Felicitation Volume*, Delhi 1981, Vol. III, pp. 154–64.

<sup>115</sup>Cf. Mc Crindle, *India and Its Invasion by Alexander*, pp. 207–8; Chakravarti, *The Art of War in Ancient India*, pp. 32–33.

<sup>116</sup>Cf. Ravindra Kumār Sharmā, *Export and Import of Trade Materials under Maharaja Ranjit Singh: Administration Society and Economy*, published by Punjabi University Patiala, Punjab 1980, pp. 18–23.



modifications<sup>117</sup> were adopted by the business community,<sup>118</sup> Royal dignitaries,<sup>119</sup> common travellers and even by foreigners<sup>120</sup> who visited India in the course of their respective journeys.<sup>121</sup> Samuel Purchas saw in the country many fine carts gilded and covered with silk and fine cloth.<sup>122</sup> In Vijayanagar empire, it appears, carts were not used on a large scale owing to the bad condition of the roads.<sup>123</sup> Thevenot refers to the use of chariots which were flat and even having a border four fingers broad with pillars all round.<sup>124</sup> The number of pillars depended upon the taste of the owner but normally it did not exceed eight. It had two wheels, each having eight spokes four or five fingers thick; traders,<sup>125</sup> businessmen,<sup>126</sup> bureaucrats<sup>127</sup> covered the wooden floor of the chariot with a nice carpet and "though of leather were

<sup>117</sup>Cf. The paintings of the Persian MS. *Khandan-i-Wakiyat-i-Taimuriya*, Khuda Bux Oriental Library, Patna, pp. 81–83, Abul Fazl, *Ain-i-Akbari*, Persian Text, Vol. I, pp. 152–54. For a beautiful contemporary painting of a Bullock chariot by Abul Hasan Noddiruz-Zaman, the greatest painter of Emperor Jahāngir's time, refers to Shanti Swarup, *The Arts and Crafts of India and Pakistan*, Bombay 1968.

<sup>118</sup>Peter Mundy, *Travels of 1608–1667*, Hakluyt Society Ed. Temple and Anstey, London 1914, Vol. II, pp. 45–46; J.D. Thevenot, *Indian Travels of Thevenot and Carari*. Ed. S.N. Sen, National Archives of India, New Delhi 1949, p. 29; J.B. Tavernier, *Travels of—Tr. and Ed. Ball*, Vol. I, p. 29.

<sup>119</sup>Cf. Sharmā, *Economic History of the Eighteenth Century*, *Proceedings of the 14th Session of the Punjab History Conference*, March 28–30, 1980, Punjabi University, Patiala, pp. 161–65.

<sup>120</sup>Cf. J. Ovington, *A Voyage to Surat in the year 1689*, Ed. H.G. Rawlingson, Oxford 1929, p. 254; Rennel, *Memoir of a map of Hindustan of the Moghul Empire*, 1788, p. 255, Sir Thomas Roe, *Embassy of 1615–1619*, Ed. W. Foster, Hakluyt Society, 1926, p. 298.

<sup>121</sup>Pietro Della Valle, *Travels of Ed. Grey*, Hakluyt Society, London 1891, Vol. I, pp. 21–24; *Embassy of Sir Thomas Roe*, II, p. 537, Tavernier, pp. 142–47.

<sup>122</sup>Samuel Purchas, *Purchas His Pilgrims*, Glasgow 1905–7, pp. 76–79.

<sup>123</sup>T.V. Mahalingham, *Life in the Vijaynagar Empire*, Madras n.d. p. 153.

<sup>124</sup>Thevenot, op. cit., p. 75.

<sup>125</sup>Sharmā, *Development of Trade and Commerce under Maharaja Ranjit Singh*, *Proceedings of the 15th Session of the Punjab History Conference*, Punjabi University, Patiala, March 13–15, 1981, pp. 152–6.

<sup>126</sup>Sharmā, *The Role of Business Community in the Development of the Northern Indian Society*, Paper contributed in the Seminar: *Urbanization and the Society*, Government of Bihar, Patna Museum, Patna, Bihar 1983, also my paper entitled *Maharaja Ranjit Singh and the Business Community: A Study based on the Private Papers*, *Proceedings of the Seminar: 200th birth anniversary of Maharaja Ranjit Singh*, held on 18th – 19th December, 1980, G.T.B. Khalsa College, Delhi University, Delhi 1980.

<sup>127</sup>Cf. Bikaneri Chariot preserved in the Ganga Golden Jubilee museum, Bikaner, Department of Museum and Archaeology Government of Rajasthan, Cabin No. 2, Chariot No. 6; Cf. Sharmā, *Military System of the Bikaner State C. 1545 to 1947 A.D. Bana Bhatta Commemoration Volume*, Gaya, Bihar 1985.



interwoven from pillar to pillar to keep them from falling out." Those who could afford it had their chariotgs ornamented: their windows were adorned with gilded leather or silk hangings, their mattresses were made of silk quilts.<sup>128</sup> Cushions were also used.<sup>129</sup> Even as late as 1800s, a beautiful canopy was used sometimes as a protection against the sun by the people of northern India.<sup>130</sup> The rulers of medieval India paid special attention to develop trade matter and encouraged wheeled technology by providing many facilities and privileges to craftsmen in their states.<sup>131</sup> To meet staggering demands of the industries and trade, the people engaged in business, and once again opted for ox in place of horse or mule.<sup>132</sup> We are informed by medieval travellers, particularly Thevenot, that oxen were in great demand and were even used by the nobles to draw their carriages.<sup>133</sup> To make them look more beautiful and impressive, they would "deck the ends of their horns with sheath of copper and even clothe them."<sup>134</sup> These oxen were well fed and looked like elephants.<sup>135</sup> Oxen cart would cover 12–15 leagues a day. They could travel for about two months at their speed. To hire such a coach<sup>136</sup> cost a rupee per day.<sup>137</sup> Thevenot found these chariots very comfortable; according to him the finest chariots were built at Ihattāh.<sup>138</sup> The Mughal Emperor Akbar preferred to drive in

<sup>128</sup>Abul Fazl, *Āin-i-Akbarī*, Persian Text, Vol. I, pp. 152–153.

<sup>129</sup>Cf. Jodhpuri Chariot preserved in the His Highness of Jodhpur's Ummed museum, Jodhpur. Cf. Sharmā, *Military System of the Jodhpur State C. 1200–1947*, A.D., Pragati Prakashan, Delhi 1985, Chapter on the Chariots.

<sup>130</sup>Cf. Jaipuri Chariots preserved in the Sawai Man Singh II museum Tripoliya, Jaipur Central Room, Cabin No. 6, Chariots of Maharaja Sawai Jai Singh II and Sawai Madho Singh, The rulers of Jaipur discarded chariots as war vehicles in favour of mounted cavalry but continued to use them for commercial purposes and that too with a beautiful canopy on it. Cf. Sharmā, *Military System of the Kachhwaha State of Ajmer and Jajpur. C. 1500–1947 A.D.*, "Indica. Journal of the Heras Research Institute," St. Xavier College Building, Bombay 1985, pp. 135–145.

<sup>131</sup>The rulers of Udaipur established a school and an Institute for the purpose. They also patronised specialists and craftsmen to develop this science in their area. Cf. Sharmā, *Vrsabha Cikitsa Sambandhi ek mahattvapurna Granth*, Rtamdharma, Journal of M.M.M. Institute, Deoria, Uttar Pradesh, January, 1977, Vol. XXV, pp. 45–54.

<sup>132</sup>Mundy, op. cit., II, pp. 192, 215, 281.

<sup>133</sup>Thevenot, op. cit., p. 273.

<sup>134</sup>J.A. Mandelslon, *Travels of*, ed. Commissariat, Oxford 1931, Vol. III, p. 122.

<sup>135</sup>John Bruce, *Annals of the East India Company*, London 1810, Vol. I, pp. 135–9.

<sup>136</sup>Tavenier, op. cit., p. 29.

<sup>137</sup>Ibid., p. 29.

<sup>138</sup>Ibid., p. 25.

a two-horse chariot wherein he would sit "cross-legged upon a couch covered with scarlet rugs."<sup>139</sup> It is interesting to note that among the presents sent by the East India company to Mughal Emperor Jahāngīr, there was an English coach which created some sensation at the Mughal court and was used as a model by local craftsmen.<sup>140</sup> Later Jahāngīr presented it to Malika Nūrbahān. Its English living was taken off and the coach was covered with gold, velvet and decoration.<sup>141</sup> It was common practice to travel in a chariot during the entire medieval period. It should also be noted here that the camel driven chariots were also used in Rājasthān, Gūjarāt, Sindh and Multān and for this the karigar (craftsmen) of Bīkāner, Jōdhpur and Jaisalmer were known for skilled craftsmanship.<sup>142</sup>

## IX

During the reign of East India Company and British raj chariots and bullockcharts remained a most common mode of transport and travel. The Indian princely states too favoured them, as can be seen from the royal chariots of Bīkāner, Jōdhpur, Jaipur, Udaipur, Kōtā, Būndī, Jhālāwār, Kīsangarh, Bhōpal, Tikamgarh, Mandī, Sūket, Nahān, Kālā Kankār, Rewā, Gwalior, Indore, etc., still preserved in their respective museums.

It is interesting to note here that even after the independence the total investment on the cart vehicle was much more than that invested on Indian railway or road transport.<sup>143</sup>

It can be said that India, the cradle of one of the world's oldest civilisations, was never backward in the technological advancement. The Indians may have been much more advanced in this science than many others of that age. Like all sciences, wheeled technology also passed through various evolutionary processes starting from the Indus valley civilization down to the present age and it made distinct improvement over the past. In fact the history of *ratha* is the history of Indian civilization.

<sup>139</sup>The Commentary—Father A Monserrate's Account of Akbar, Proc. A.S.B., 1912, pp. 185-221. Cf. Vincent A. Smith, *Akbar: The Great Moghul, 1542-1605*, Delhi 1966, pp. 344-45.

<sup>140</sup>Sir Thomas Roe, *Embassy of 1615-1619*, op. cit., vol. I, p. 6.

<sup>141</sup>S.M. Latif, *Agra, Historical and Descriptive*, Agra 1945, p. 28.

<sup>142</sup>Cf. Sharmā, *Military System of the Jaisalmer State C. 1145-1947 A.D.*, "Research Bulletin of Arts and Humanities," Panjab University, Chandigarh 1985.

<sup>143</sup>The statement is based on the declaration of the Indian Institute of Management and Commercial Studies, Bangalore 1980. Cf. Sharmā, *Vrishabha Manuscript of Eighteenth Century preserved in the Rajasthan Oriental Research Institute*, "Avagahana, Research Journal of Gandhi Vidya Mandir Research Centre," Sardarshahar 1979, vol. III, pp. 41-46.