**Journal of Threatened Taxa**

The international journal of conservation and taxonomy

www.threatenedtaxa.org

ISSN 0974-7907 (Online) | ISSN 0974-7893 (Print)

**SHORT COMMUNICATION**

# ODONATA (INSECTA) DIVERSITY OF SOUTHERN GUJARAT, INDIA

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26 September 2016 | Vol. 8 | No. 11 | Pp. 9339–9349
10.11609/jott.2609.8.11.9339-9349

Journal of Threatened Taxa | www.threatenedtaxa.org | 26 September 2016 | 8(11): 9339–9349



# Odonata (Insecta) diversity of southern Gujarat, India

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ISSN 0974-7907 (Online)
ISSN 0974-7893 (Print)

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**Abstract:** The diversity of the Odonata (dragonflies and damselflies) was studied in seven districts of southern area of Gujarat State in India during 2014 to 2015. A total of 55 species belonging to two suborders and 37 genera under eight families were recorded. A total of 18 species of Zygoptera (damselflies) and 37 species of Anisoptera (dragonflies) were recorded. Dang and Navsari districts were surveyed intensively and a maximum of 47 and 35 species were recorded respectively, whereas the districts that were surveyed less intensively, i.e., Bharuch (26), Valsad (21), Surat (29), Narmada (25) and Tapi (27) had comparatively low species richness. Thirty-two species are being reported for the first time from southern Gujarat, raising the total list of odonates to 60. Fifteen species namely, *Lestes elatus* Hagen in Selys, 1862; *Elattoneura nigerrima* (Laidlaw, 1917); *Dysphaea ethela* Fraser, 1924; *Paracercion malayanum* (Selys, 1876); *Pseudagrion spencei* Fraser, 1922; *Burmagomphus laidlawi* Fraser, 1924; *Cyclogomphus ypsilon* Selys, 1854; *Microgomphus torquatus* (Selys, 1854); *Onychogomphus acinaces* (Laidlaw, 1922); *Hylaeothemis indica* Fraser, 1946; *Lathrecista asiatica* (Fabricius, 1798); *Rhodothemis rufa* (Rambur, 1842); *Tramea limbata* (Desjardins, 1832); *Trithemis kirbyi* Selys, 1891 and *Zyxomma petiolatum* Rambur, 1842 are recorded for the first time from Gujarat State raising the number of odonates of Gujarat State to 80 species.

**Keywords:** Damselflies, Diversity, Dragonflies, Odonates, southern Gujarat, Western Ghats.

Globally 5,952 species of odonates are known and of this 474 species in 142 genera and 18 families have been recorded in India (Subramanian 2014). Information on the diversity of odonates in several neighboring states to Gujarat State is available, as well as some regional studies within neighboring states. However, very little has been published about the odonates of Gujarat State. Asana & Makino (1935) studied chromosomes of *Tramea chinensis* at Ahmedabad. Shull & Nadkerny (1967) reported five species of dragonflies attracted to mercury light at Ahwa, Dangs. Prasad (2004) listed 48 species collected by Zoological Survey of India (ZSI) scientists during a general faunistic survey of Gujarat State. Sharma (2009) published work on the odonates of arid and semi-arid regions of India and listed 58 species from Gujarat based on specimens available in museums. Gandhi (2012) listed 45 species of odonates from Vadodara District of Central Gujarat but was able to verify only 28 species. Rohmare et al. (2015) reported 42 species of odonates from central Gujarat with seven new records for Gujarat. Except for Rohmare et al. (2015) there is no other detailed regional study on the odonates of Gujarat.

Gujarat State is on the west coast of India; its

**DOI:** http://dx.doi.org/10.11609/jott.2609.8.11.9339-9349 | **ZooBank:** urn:lsid:zoobank.org:pub:7FD66E5A-E794-47A7-B8E6-2CE55F846810

**Editor:** Nancy van der Poorten, Toronto, Canada. **Date of publication:** 26 September 2016 (online & print)

**Manuscript details:** Ms # 2609 | Received 09 March 2016 | Final received 03 September 2016 | Finally accepted 18 September 2016

**Citation:** Rathod, D.M., B.M. Parasharya & S.S. Talmale (2016). Odonata (Insecta) diversity of southern Gujarat, India. *Journal of Threatened Taxa* 8(11): 9339–9349; http://dx.doi.org/10.11609/jott.2609.8.11.9339-9349



**Funding**: Self-funded.

**Conflict of Interest**: The authors declare no competing interests.

**Acknowledgements:** Authors are grateful to the Director, Zoological Survey of India, Kolkata and Dr. S. Sambath, Scientist-D and Officer-in-Charge, ZSI, CZRC, Jabalpur for providing the facilities. Encouragement by Dr. K.B. Kathiria, Dean, PG studies, Anand Agricultural University, Anand is sincerely acknowledged. We are thankful to Vishal Mistry, Jenis Patel, Mayank Patel, Vaishali Parmar and N.A. Thakor for their valuable support in field survey. We are grateful to Dr. Z.P. Patel, Principal, College of Agriculture, Waghai for providing accommodation and support. We also thankful to Jugal Patel for photograph of *Pseudagrion spencei*. First author acknowledges UGC for award of Rajiv Gandhi National Fellowship for pursuing PhD programme.

southern border encompasses the northern limit of the Western Ghats, a UNESCO World Heritage Site and one of the hot-spots of biological diversity. The Western Ghats are known to support a number of species of Odonata: 176 species have been recorded from the Western Ghats, including 68 species endemic to the region (Subramanian 2007). However, the northern region of the Western Ghats (which includes the states of Gujarat, Maharashtra, and Goa) is under-explored with little documentation of the Odonata (Koparde et al. 2014). The forest area of the district of Dang and the surrounding districts of southern Gujarat are climatically a part of the Western Ghats and comprise its northern-most end. However, except for some studies on spiders (Patel 2003; Siliwal et al. 2003; Parasharya et al. 2011) and herpetofauna (Vyas 2004), this area lacks detailed studies on faunal diversity. Almost nothing is known about the odonates of southern Gujarat. Hence, the present study in southern Gujarat was planned.

## Materials And Methods

### Study Area

The diversity of odonates was studied in all types of wetlands of seven districts of southern Gujarat, i.e., Bharuch, Narmada, Surat, Tapi, Navsari, Valsad and Dang districts during 2014 to 2015 (Fig. 1). Southern Gujarat is broadly defined as the area south of the river Narmada, reaching up to the border of Maharashtra. Its western side touches the Arabian Sea whereas the eastern side touches Maharashtra. The southern Gujarat region lies between 21$^0$14'–22$^0$49'N & 72$^0$22'–74$^0$15'E. This region is the wettest region of Gujarat. The plains of southern Gujarat are irrigated by Purna, Par, Damanganga, Auranga, Kolak, Ambica, Darota, Narmada, and Tapi rivers. The region shows a typical sub-humid to humid climate. The mean annual temperature is about 26$^0$C and in the summer and winter, the mean maximum temperatures are 46$^0$C and 22$^0$C respectively. The southern districts have the highest annual rainfall, i.e., Dang (2444mm), Valsad (2122mm), and Navsari (1806mm). Amongst the northern districts, Bharuch receives 707mm annual rainfall, Narmada 1065mm and Tapi and Surat districts each about 1300mm. The study area is rich in flora: a total of 700 species of flowering plants are reported from Protected areas of the Dang District where the present study was concentrated. It has three wildlife sanctuaries: Shoolpaneshwar Wildlife Sanctuary (WS) in the Narmada District, Purna WS in the Dang District, and Vansda National Park in the Navsari District (Bhatt et al. 2014). The forest of the Dang District is south Indian tropical moist deciduous forests- 3A/$C_1$ type. The subtypes within the area are southern moist mixed deciduous forests-3B/$C_2$, Bamboo brakes-5/$E_9$ and tropical riverine forest-5/1S1 (Champion & Seth 1968; Patel 2003). Shoolpaneshwar WLS is also classified as moist mixed deciduous type forest (Singh 1998). Besides high annual precipitation, the region has an extensive network of irrigation canals. Images 17–20 show some of the study sites.

### Sampling methods

Adult odonates were collected from all types of wetlands in the study area using a standard insect net. Wetlands in non- Protected Areas were surveyed during July to October. The specimens were preserved in 70% alcohol and by placing them in an envelope that was labeled properly with details of species, date and place of collection. Additional specimens were preserved as dry following standard procedure. Collections were made only from non-protected areas. The voucher specimens were deposited at Anand Agricultural University, Anand. Details of the sampling localities are given in Table 1.

The specimens were identified with the help of photographic guides (Emiliyamma et al. 2005; Subramanian 2009; Nair 2011; Kiran & Raju 2013) and Fraser (1933, 1934, 1936). The scientific names follow Subramanian (2014). Identification of specimens was confirmed by one of us (SST) at the Zoological Survey of India, Jabalpur.

## Results And Discussion

### Diversity of odonates within southern Gujarat

A total of 55 species belonging to two suborders and 37 genera under eight families were collected from seven districts of southern Gujarat (Table 2). Eighteen species of Zygoptera (damselflies) and 37 species of Anisoptera (dragonflies) were recorded. In this study, Zygoptera and Anisoptera were represented by four families each.

The highest number of odonate species (47) was recorded in Dang District (30 species of Anisoptera and 17 species of Zygoptera). Navsari District ranked second with 35 species (23 species of Anisoptera and 12 species of Zygoptera). Species richness was comparatively low in the remaining districts: Bharuch (26), Valsad (21), Surat (29), Narmada (25) and Tapi (27) (Table 3). The species richness of the Dang and Navsari districts was highest. It is possible that the high species richness was reflection of the intensity and longer surveys that were done in the Dang and Navsari districts rather than true ecological species richness.

The highest numbers of odonates recorded belonged to the family Libellulidae (28 species), followed by

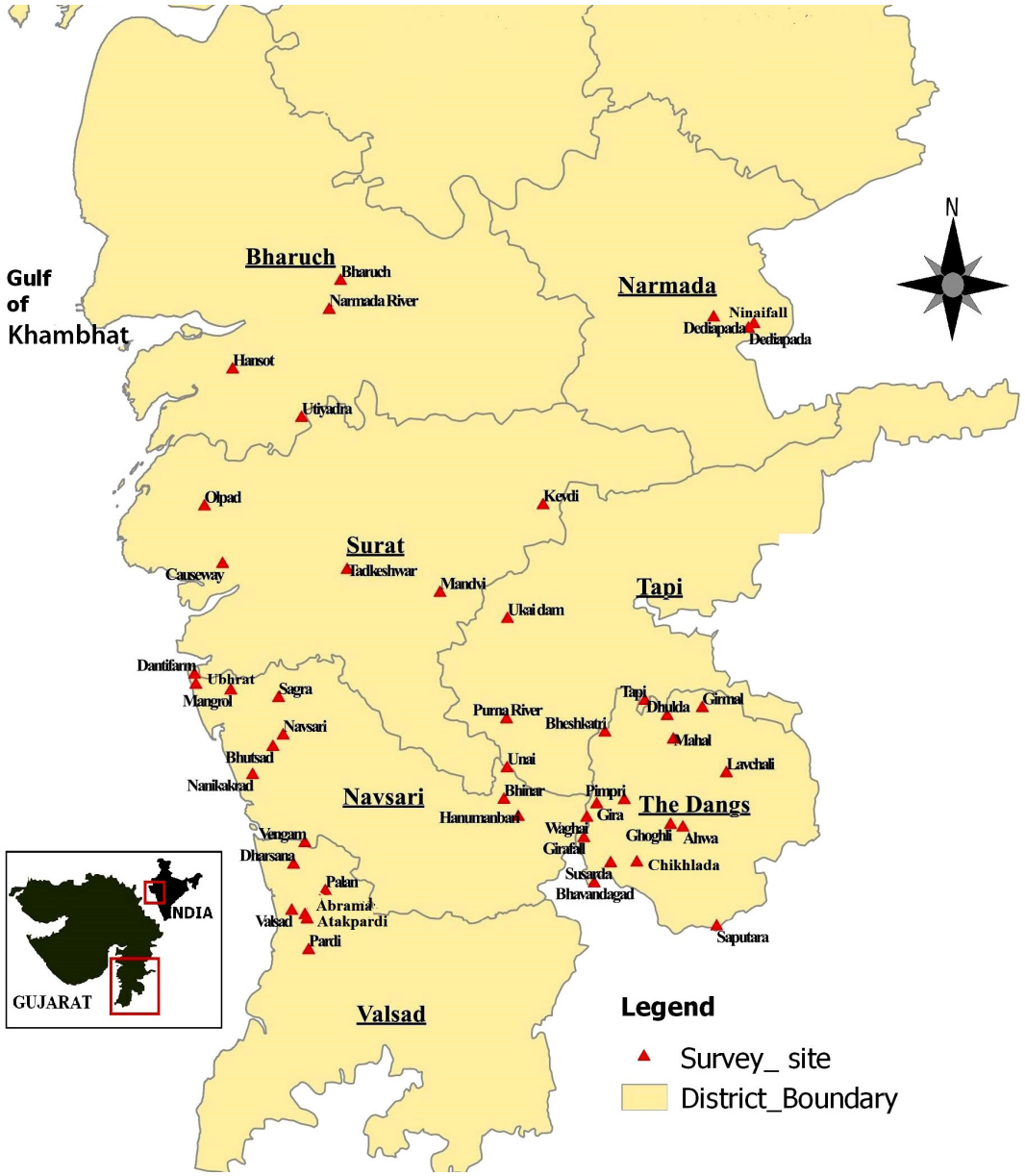


**Figure 1. Study area showing collection/ observation sites of southern Gujarat**

Coenagrionidae (11 species), Gomphidae (6 species), Lestidae and Platycnemididae (3 species each), Aeshnidae (2 species), Macromiidae and Euphaeidae (one species each) (Table 2).

Twelve species, i.e., *Agriocnemis pygmaea* (Rambur, 1842); *Ceriagrion coromandelianum* (Fabricius, 1798); *Ischnura senegalensis* (Rambur, 1842); *Pseudagrion decorum* (Rambur, 1842); *Acisoma panorpoides* (Rambur, 1842); *Brachythemis contaminata* (Fabricius, 1793); *Bradinopyga geminata* (Rambur, 1842); *Crocothemis servilia* (Drury, 1770); *Diaplacodes trivialis* (Rambur, 1842); *Neurothemis tullia* (Drury, 1773); *Orthetrum sabina* (Drury, 1770) and *Trithemis aurora* (Burmeister, 1839) were most widely distributed and common as they were recorded in all seven districts. Four species were recorded in six districts and seven species were recorded in five districts (Table 2). The absence of these species in one or two districts may be due to comparatively less survey efforts since these species are otherwise widely distributed in India and hence likely to be widespread in the entire southern Gujarat.

Nine species were recorded only in the Dang district: *Lestes elatus* Hagen in Selys, 1862; *Dysphaea ethela* Fraser, 1924; *Agriocnemis splendidissima*

**Table 1. Sampling localities with voucher specimens number**

| # | Locality name | District | Longitude (decimal degrees) | Latitude (decimal degrees) | Altitude (m) | Date of survey/collection |
|---|---|---|---|---|---|---|
| 1 | Chikhlada | Dang | 73.594509 | 20.692472 | 211 | 4.x.2015, 22.xi.2015 |
| 2 | Saputara | Dang | 73.749220 | 20.576463 | 870 | 7.vii.2015, 4.ix.2015, 22.xi.2015 |
| 3 | Mahal | Dang | 73.665219 | 20.915272 | 202 | 24.x.2015, 9.x.2015, 2.ix.2015 |
| 4 | Bheshkatri | Dang | 73.532623 | 20.928041 | 121 | 24.x.2015, 2.ix.2015 |
| 5 | Waghai | Dang | 73.489780 | 20.770728 | 111 | 17.x.2014, 23.x.2015, 1.ix.2015 |
| 6 | Ahwa | Dang | 73.683690 | 20.755795 | 467 | 19.x.2014, 23.x.2015 3.ix.2015 |
| 7 | Pimpri | Dang | 73.570172 | 20.805617 | 170 | 18.x.2014, 24.x.2015, 3.ix.2015 |
| 8 | Gira | Dang | 73.516694 | 20.798003 | 133 | 24.x.2015, 9.x.2015, 1.ix.2015 |
| 9 | Bhavandagad | Dang | 73.511924 | 20.654578 | 322 | 24.x.2015, 9.x.2015 |
| 10 | Girafall | Dang | 73.491778 | 20.736641 | 144 | 18.x.2014, 22.x.2015 |
| 11 | Dhulda | Dang | 73.653250 | 20.958020 | 192 | 9.x.2015 |
| 12 | Susarda | Dang | 73.543725 | 20.691097 | 182 | 22.x.2015 |
| 13 | Ghoghli | Dang | 73.659822 | 20.760656 | 362 | 19.x.2014 |
| 14 | Lavchali | Dang | 73.768034 | 20.854329 | 297 | 3.ix.2015 |
| 15 | Girmal | Dang | 73.721397 | 20.972397 | 273 | 3.ix.2015, 24.x.2015 |
| 16 | Navsari | Navsari | 72.908894 | 20.922694 | 15 | 17.x.2014, 2.xi.2014 |
| 17 | Bhutsad | Navsari | 72.889046 | 20.901905 | 10 | 17.x.2014 |
| 18 | Nanikakrad | Navsari | 72.849692 | 20.851081 | 8 | 17.x.2014 |
| 19 | Sagra | Navsari | 72.900197 | 20.990642 | 6 | 3.xi.2014 |
| 20 | Mangrol | Navsari | 72.807381 | 21.004156 | 3 | 3.xi.2014 |
| 21 | Ubhrat | Navsari | 72.739636 | 21.014472 | 5 | 3.xi.2014 |
| 22 | Dantifarm | Navsari | 72.737089 | 21.032881 | 3 | 3.xi.2014 |
| 23 | Hanumanbari | Navsari | 73.364649 | 20.775109 | 98 | 3.xi.2014, 9.x.2015 |
| 24 | Bhinar | Navsari | 73.336875 | 20.806147 | 77 | 3.xi.2014, 23.x.2015 |
| 25 | Unai | Surat | 73.342997 | 20.863444 | 72 | 23.x.2015 |
| 26 | Causeway | Surat | 72.791394 | 21.232989 | 11 | 3.xi.2014 |
| 27 | Tadkeshwar | Surat | 73.032939 | 21.222155 | 29 | 21.x.2015 |
| 28 | Kevdi | Surat | 73.412778 | 21.339167 | 108 | 27.xii.2014 |
| 29 | Mandvi | Surat | 73.212963 | 21.180680 | 34 | 21.x.2015 |
| 30 | Olpad | Surat | 72.756403 | 21.336978 | 6 | 16.x.2014 |
| 31 | Valsad | Valsad | 72.925522 | 20.604864 | 17 | 17.x.2014, 8.x.2015 |
| 32 | Atakpardi | Valsad | 72.955284 | 20.589258 | 15 | 17.x.2014, 8.x.2015 |
| 33 | Dharsana | Valsad | 72.929031 | 20.688525 | 10 | 17.x.2014 |
| 34 | Pardi | Valsad | 72.958412 | 20.533333 | 13 | 8.x.2015 |
| 35 | Palan | Valsad | 72.990639 | 20.640602 | 24 | 9.x.2015 |
| 36 | Vengam | Valsad | 72.950916 | 20.727693 | 13 | 17.x.2014 |
| 37 | Abrama | Valsad | 72.951194 | 20.597253 | 12 | 8.x.2015 |
| 38 | Hansot | Bharuch | 72.810953 | 21.584111 | 10 | 16.x.2014 |
| 39 | Narmada River | Bharuch | 72.998176 | 21.691496 | 17 | 16.x.2014 |
| 40 | Utiyadra | Bharuch | 72.944683 | 21.496800 | 22 | 21.xii.2015 |
| 41 | Bharuch | Bharuch | 73.020281 | 21.743760 | 22 | 16.x.2014 |
| 42 | Dediapada | Narmada | 73.810833 | 21.657778 | 401 | 2.x.2015 |
| 43 | Dediapada | Narmada | 73.743333 | 21.677778 | 287 | 2.x.2015 |
| 44 | Ninaifall | Narmada | 73.821389 | 21.665833 | 441 | 26.xii.2015, 2.x.2015 |
| 45 | Tapi | Tapi | 73.610231 | 20.985368 | 179 | 21.x.2015, 2.ix.2015 |
| 46 | Ukai dam | Tapi | 73.343804 | 21.133651 | 61 | 21.x.2015 |
| 47 | Purna River | Tapi | 73.341903 | 20.952031 | 76 | 23.x.2015 |

Laidlaw, 1919*; Paracercion malayanum* (Selys, 1876)*; Burmagomphus laidlawi* Fraser, 1924*; Cyclogomphus ypsilon* Selys, 1854*; Microgomphus torquatus* (Selys, 1854)*; Onychogomphus acinaces* (Laidlaw, 1922) and *Hylaeothemis indica* Fraser, 1946. Out of these nine species, two species, *Burmagomphus laidlawi* and *Onychogomphus acinaces,* are endemic to the Western Ghats only (Emiliyamma & Subramanian 2013; Babu et al. 2013). Close-up photographs of the anal appendages of *O. acinaces* (Image 10a,b) clearly show a shorter superior anal appendage which distinguishes it from *Onychogomphus nilgiriensis* (Fraser 1922) (Laidlaw 1922; Kiran & Raju 2013). The two species otherwise look identical in the field. Two specimens of *O. acinaces* were collected during September, 2015. Forty-seven species were recorded from water bodies or streams on the roadside in the middle forest of the area but outside the protected area in Dang District. A detailed survey of two protected areas (Vansda NP and Purna WS) may yield more habitat-specialist species. The present study was done in the areas having intensive anthropogenic pressure and the known fact is that odonate diversity is expected to be low in an altered forest habitat (Subramanian 2007; Subramanian et al. 2011; Adu et al. 2015; Edegbene et al. 2015).

Two other species with a restricted distribution were *Pseudagrion spencei* Fraser, 1922 and *Potamarcha congener* (Rambur, 1842) which were collected only from Bharuch and Navsari districts. During the survey, most of the blue coloured damselflies were visually identified. Amongst a few collected, one from Bharuch district turned out to be *Pseudagrion spencei* (Image 5). In previous survey during 2015, we also collected *Pseudagrion spencei* from the Mahi River in central Gujarat. This indicates that the collection and close examination of a few specimens of each species from a district is desirable for improving the accuracy of the survey/inventory. *Potamarcha congener* was observed as roosting communally, high in the vegetation at Navsari Agricultural University campus (Image 16). It was not encountered in other districts of southern Gujarat. Shull & Nadkerny (1967) recorded five species of dragonflies attracted to light at Ahwa, Dang. But we have recorded one more species, *Zyxomma petiolatum* Rambur, 1842 attracted to light at Navsari Agricultural University campus in October 2014.

**Comparison with earlier studies**

Prasad (2004) had reported 23 species of odonates from southern Gujarat. His records were largely from the districts of Dang (12 species), Valsad (7 species), Surat (7 species), Navsari (6 species) and Bharuch (4 species). Five species, i.e., *Lestes viridulus* Rambur, 1842*; Ischnura elegans* (Vander Linden, 1823)*; Pseudagrion hypermelas* Selys, 1876; *Neurothemis intermedia* (Rambur, 1842) and *Tetrathemis platyptera* Selys, 1878 reported earlier by Prasad (2004) were not encountered during the present study. The present study adds 37 species as new records for southern Gujarat. Combining the present inventory with earlier ones, the checklist of the odonates of southern Gujarat has reached a total of 60 species. This is about 12% of the odonate diversity of India. Prasad (2004) did not report any odonates from Narmada and Tapi districts of present day administrative boundary. Hence, in the present study, the record of 22 species from Narmada and 27 species from Tapi are first records for these districts.

Fifteen species namely, *Lestes elatus, Elattoneura nigerrima* (Laidlaw, 1917)*, Dysphaea ethela, Paracercion malayanum, Pseudagrion spencei, Burmagomphus laidlawi, Cyclogomphus ypsilon, Microgomphus torquatus*, *Onychogomphus acinaces, Hylaeothemis indica, Lathrecista asiatica* (Fabricius, 1798), *Rhodothemis rufa* (Rambur, 1842), *Tramea limbata* (Desjardins, 1832), *Trithemis kirbyi* Selys, 1891 and *Zyxomma petiolatum* are first records for Gujarat State (Images 1–15).

Rohmare et al. (2015) reported seven new species from central Gujarat, which had raised the checklist of odonates of Gujarat to 65 species. Now with the additional records of 15 species from southern Gujarat, the checklist of the odonates of Gujarat is increased to 80 species.

*Burmagomphus laidlawi* has been recorded from Amba Reserve Forest and Kolhapur district including the Western Ghats in Maharashtra (Tiple & Koparde 2015). The record of *Burmagomphus laidlawi* in Dang forest is an extension of 450–500 km north. *Onychogomphus acinaces* has not been reported from the Western Ghats area of Maharashtra (Koparde et al. 2014, 2015) and has not been mentioned in the compiled list of odonates of Maharashtra (Tiple & Koparde 2015). *Onychogomphus acinaces* also shows an extension of its range of distribution from Karnataka to Dang in southern Gujarat.

Out of 15 new records for Gujarat, at least 13 species are known to occur in the neighboring state of Maharashtra. Moreover, out of 55 species recorded from southern Gujarat, 53 species are recorded in Maharashtra (Tiple & Koparde 2015). Records of common species between southern Gujarat and Maharashtra indicate similarities in habitat structure and climatic conditions between the two regions.

**Table 2. A comparison of odonates collected from southern Gujarat in the present study with the species list of Gujarat by Prasad (2004). Species marked with an asterisk (*) are a first record for the Gujarat State. Species marked with double asterisks (**) are species not encountered during the present study but recorded earlier by Prasad (2004).**

| Taxon | IUCN status | Present study | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Bharuch | Navsari | Valsad | Dang | Surat | Narmada | Tapi | Prasad (2004) |
| **Suborder: Zygoptera** | | | | | | | | | |
| **Superfamily: Lestoidea** | | | | | | | | | |
| **Family: Lestidae** | | | | | | | | | |
| 1. **Lestes elatus* Hagen in Selys, 1862 | LC | | | | + | | | | |
| 2. *Lestes thoracicus* Laidlaw, 1920 | LC | | + | | + | | | | |
| 3. *Lestes umbrinus* Selys, 1891 | DD | | + | | + | | | | |
| 4. ***Lestes viridulus* Rambur, 1842 | LC | | | | | | | | + |
| **Superfamily: Calopterygoidea** | | | | | | | | | |
| **Family: Euphaeidae** | | | | | | | | | |
| 5. **Dysphaea ethela* Fraser, 1924 | DD | | | | + | | | | |
| **Superfamily: Coenagrionoidea** | | | | | | | | | |
| **Family: Platycnemididae** | | | | | | | | | |
| 6. *Copera marginipes* (Rambur, 1842) | LC | | + | + | + | | + | + | |
| 7. *Disparoneura quadrimaculata* (Rambur, 1842) | LC | | + | | + | + | + | + | + |
| 8. **Elattoneura nigerrima* (Laidlaw, 1917) | DD | | + | | + | + | + | + | |
| **Family: Coenagrionidae** | | | | | | | | | |
| 9. *Agriocnemis pygmaea* (Rambur, 1842) | LC | + | + | + | + | + | + | + | + |
| 10. *Agriocnemis splendidissima* Laidlaw, 1919 | LC | | | | + | | | | + |
| 11. *Ceriagrion coromandelianum* (Fabricius, 1798) | LC | + | + | + | + | + | + | + | |
| 12. *Ischnura aurora* (Brauer, 1865) | LC | + | + | | + | + | + | + | + |
| 13. ***Ischnura elegans* (Vander Linden, 1823) | LC | | | | | | | | + |
| 14. *Ischnura nursei* (Morton, 1907) | LC | | | | + | | + | | |
| 15. *Ischnura senegalensis* (Rambur, 1842) | LC | + | + | + | + | + | + | + | + |
| 16. **Paracercion malayanum* (Selys, 1876) | NA | | | | + | | | | |
| 17. *Pseudagrion decorum* (Rambur, 1842) | LC | + | + | + | + | + | + | + | + |
| 18. ***Pseudagrion hypermelas* Selys, 1876 | LC | | | | | | | | + |
| 19. *Pseudagrion microcephalum* (Rambur, 1842) | LC | + | + | + | + | + | + | | |
| 20. *Pseudagrion rubriceps* Selys, 1876 | LC | | + | | + | + | + | + | |
| 21. **Pseudagrion spencei* Fraser, 1922 | LC | + | | | | | | | |
| **Suborder: Anisoptera** | | | | | | | | | |
| **Super family: Aeshnoidea** | | | | | | | | | |
| **Family: Aeshnidae** | | | | | | | | | |
| 22. *Anax guttatus* (Burmeister, 1839) | LC | + | + | + | + | + | | + | |
| 23. *Anax immaculifrons* Rambur, 1842 | LC | | + | + | + | | + | | |
| **Superfamily: Gomphoidea** | | | | | | | | | |
| **Family: Gomphidae** | | | | | | | | | |
| 24. **Burmagomphus laidlawi* Fraser, 1924 | DD | | | | + | | | | |
| 25. **Cyclogomphus ypsilon* Selys, 1854 | NA | | | | + | | | | |
| 26. *Ictinogomphus rapax* (Rambur, 1842) | LC | + | + | + | + | + | | | |
| 27. **Microgomphus torquatus* (Selys, 1854) | DD | | | | + | | | | |
| 28. **Onychogomphus acinaces* (Laidlaw, 1922) | DD | | | | + | | | | |

| Taxon | IUCN status | Present study | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Bharuch | Navsari | Valsad | Dang | Surat | Narmada | Tapi | Prasad (2004) |
| *29. Paragomphus lineatus* (Selys, 1850) | LC | + | | | + | + | | | |
| **Superfamily: Libelluloidea** | | | | | | | | | |
| **Family: Macromiidae** | | | | | | | | | |
| *30. Epophthalmia vittata* Burmeister, 1839 | LC | | + | + | + | | | | |
| **Family: Libellulidae** | | | | | | | | | |
| *31. Acisoma panorpoides* (Rambur, 1842) | LC | + | + | + | + | + | + | + | |
| *32. Brachydiplax sobrina* (Rambur, 1842) | LC | + | + | | | + | | + | |
| *33. Brachythemis contaminata* (Fabricius, 1793) | LC | + | + | + | + | + | + | + | + |
| *34. Bradinopyga geminata* (Rambur, 1842) | LC | + | + | + | + | + | + | + | |
| *35. Crocothemis servilia* (Drury, 1770) | LC | + | + | + | + | + | + | + | + |
| *36. Diaplacodes lefebvrii* (Rambur, 1842) | LC | | | | + | | | | |
| *37. Diaplacodes trivialis* (Rambur, 1842) | LC | + | + | + | + | + | + | + | + |
| *38. *Hylaeothemis indica* Fraser, 1946 | DD | | | | + | | | | |
| *39. *Lathrecista asiatica* (Fabricius, 1798) | LC | | | | + | | | + | |
| *40. **Neurothemis intermedia* (Rambur, 1842) | LC | | | | | | | | + |
| *41. Neurothemis tullia* (Drury, 1773) | LC | + | + | + | + | + | + | + | + |
| *42. Orthetrum glaucum* (Brauer, 1865) | LC | + | | | + | | | | |
| *43. Orthetrum luzonicum* (Brauer, 1868) | LC | | + | | + | | + | | |
| *44. Orthetrum pruinosum* (Rambur, 1842) | LC | | + | | + | | | + | + |
| *45. Orthetrum sabina* (Drury, 1770) | LC | + | + | + | + | + | + | + | + |
| *46. Orthetrum taeniolatum* (Schneider, 1845) | LC | | | | + | + | + | + | + |
| *47. Pantala flavescens* (Fabricius, 1798) | LC | + | + | | + | + | + | + | + |
| *48. Potamarcha congener* (Rambur, 1842) | LC | | + | | | | | | + |
| *49. *Rhodothemis rufa* (Rambur, 1842) | LC | + | + | | | + | | | |
| *50. Rhyothemis variegata* (Linnaeus, 1763) | LC | + | + | + | | + | | + | |
| *51. **Tetrathemis platyptera* Selys, 1878 | LC | | | | | | | | + |
| *52. Tholymis tillarga* (Fabricius, 1798) | LC | + | + | + | | | | + | + |
| *53. Tramea basilaris* (Palisot de Beauvois, 1805) | LC | | | | | + | | + | |
| *54. *Tramea limbata (*Desjardins, 1832) | LC | | + | + | + | + | | | |
| *55. Trithemis aurora* (Burmeister, 1839) | LC | + | + | + | + | + | + | + | + |
| *56. Trithemis festiva* (Rambur, 1842) | LC | | | | + | + | + | + | + |
| *57. Trithemis pallidinervis* (Kirby, 1889) | LC | + | + | + | + | + | | | |
| *58. *Trithemis kirbyi* Selys, 1891 | LC | | | | + | | + | + | |
| *59. Urothemis signata* (Rambur, 1842) | LC | | | | + | | | | |
| *60. *Zyxomma petiolatum* Rambur, 1842 | LC | | + | | + | + | | | |

IUCN status: LC - Least Concern, DD - Data Deficient, NA - Not Available

**Table 3. Species richness of dragonflies and damselflies in southern Gujarat**

| | Districts | No. of species | | Total |
|---|---|---|---|---|
| | | Dragonfly | Damselfly | |
| 1 | Bharuch | 19 | 7 | 26 (47%) |
| 2 | Navsari | 23 | 12 | 35 (63%) |
| 3 | Valsad | 15 | 6 | 21 (38%) |
| 4 | Dang | 30 | 17 | 47 (85%) |
| 5 | Surat | 20 | 9 | 29 (52%) |
| 6 | Narmada | 14 | 11 | 25 (45%) |
| 7 | Tapi | 18 | 9 | 27 (49%) |
| | **Total** | 37 | 18 | 55 (100%) |

Sharma (2009) listed odonate species of the arid and semi-arid regions of India, covering four states, i.e., Punjab, Haryana, Rajasthan and Gujarat, based on information from specimens available at various museums. He did not mention the locality of any of the species. Hence, his list is general list of Gujarat. It is true that the major area of Gujarat is arid or semi-arid but the Dang and Valsad districts are not arid or semi-arid but a part of the Western Ghats on their southern-most end. His list included all the species listed by Prasad (2004), which included at least 12 species exclusively collected from Dang and Valsad districts. Though most of Gujarat State is arid or semi-arid, the area of Dang and Valsad districts are part of the Western Ghats moist mixed deciduous forest.

Out of 55 species reported in the present study, 38 species have been reported by Rohmare et al. (2015) from central Gujarat. However, four species recorded by them in central Gujarat were not recorded during the present study.

None of the species from the present study is listed as a Threatened species in the IUCN Red List, however at least seven species are listed under 'Data Deficient' species (IUCN, 2015). The Data Deficient species recorded from southern Gujarat are as follows: *Lestes umbrinus, Elattoneura nigerrima, Dysphaea ethela, Burmagomphus laidlawi, Microgomphus torquatus, Onychogomphus acinaces* and *Hylaeothemis indica.* Hence, current records may help to undertake threat analysis.

Odonates found at undisturbed habitat with good riparian vegetation were specialists with narrow distribution ranges. Recent studies on dragonfly ecology from the Western Ghats indicated that families like Protoneuridae (Bambootails), Platystictidae (Reedtails), Calopterygidae (Glories), Euphaeidae (Torrent Dart),

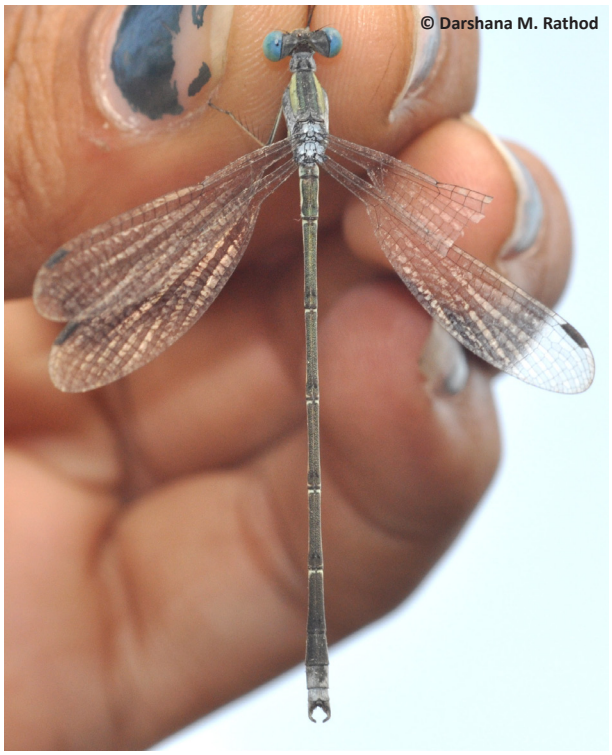


**Image 1.** ***Lestes elatus***


**Image 2.** ***Dysphaea ethela***


**Image 3.** ***Elattoneura nigerrima***


Image 4. *Paracercion malayanum*

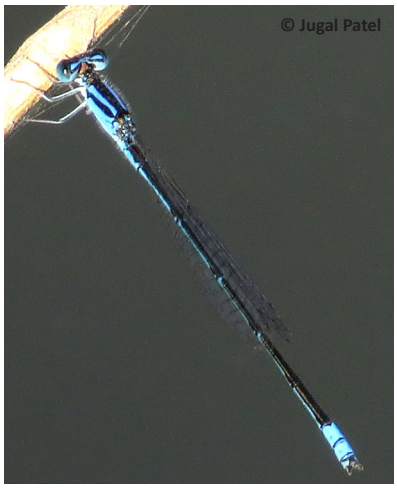


Image 5. *Pseudagrion spencei*


Image 6. *Burmagomphus laidlawi*


Image 7. *Cyclogomphus ypsilon*


Image 8. *Microgomphus torquatus*


Image 9. *Hylaeothemis indica*


Image 10. *Onychogomphus acinaces*


Image 10a. Lateral view of anal appendages of *Onychogomphus acinaces*


Image 10b. Dorsal view of anal appendages of *Onychogomphus acinaces*


Image 11. *Lathrecista asiatica*


Image 12. *Rhodothemis rufa*


Image 13. *Tramea limbata*


Image 14. *Trithemis kirbyi*


Image 15. *Zyxomma petiolatum*


Image 16. Roosting of *Potamarcha congener*


Image 17. Reservoir at Saputara


Image 18. Marshy pond at Navsari


Image 19. Waterfall at Rajpipla


Image 20. River at Dang

Macromiidae (Torrent Hawks) and Gomphidae (Clubtails) are good indicators of the health of riverine ecosystems (Subramanian 2009). In the present study, nine species *i.e. Lestes elatus, Dysphaea ethela, Agriocnemis splendidissima, Paracercion malayanum, Burmagomphus laidlawi, Cyclogomphus ypsilon, Microgomphus torquatus, Onychogomphus acinaces* and *Hylaeothemis indica* were recorded only from Dang forest, the habitat which has least anthropogenic disturbances.

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Journal of Threatened Taxa

OPEN ACCESS



**ISSN 0974-7907 (Online); ISSN 0974-7893 (Print)**

**September 2016 | Vol. 8 | No. 11 | Pages: 9289–9396**
**Date of Publication: 26 September 2016 (Online & Print)**
**DOI: 10.11609/jott.2016.8.11.9289-9396**
www.threatenedtaxa.org



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