Journal of Threatened Taxa

Building evidence for conservation globally

www.threatenedtaxa.org

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

COMMUNICATION

DIVERSITY AND DISTRIBUTION OF FRESHWATER TURTLES (REPTILIA: TESTUDINES) IN GOA, INDIA

Trupti D. Jadhav, Nitin S. Sawant & Soorambail K. Shyama

26 August 2018 | Vol. 10 | No. 9 | Pages: 12194–12202
10.11609/jott.2835.10.9.12194-12202

COMMUNICATION

Journal of Threatened Taxa | www.threatenedtaxa.org | 26 August 2018 | 10(9): 12194–12202

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

Diversity and distribution of freshwater turtles (Reptilia: Testudines) in Goa, India

Trupti D. Jadhav [1], Nitin S. Sawant [2] & Soorambail K. Shyama [3]

[1,2,3] Department of Zoology, Goa University, Taleigao Plateau, Goa 403206, India
[1] truptijadhav2@gmail.com (corresponding author), [2] nitinnature@yahoo.co.in, [3] skshyama@gmail.com

OPEN ACCESS

Abstract: Freshwater turtles symbolize a key component of biodiversity in aquatic ecosystems. Of the 356 living species of turtles and tortoises in the world, 34 species are recorded from India. The number of freshwater turtle and tortoise species found in the state of Goa, however, is debatable. No study specific to the Goa region has been carried out on freshwater turtles. Therefore, baseline data on diversity and distribution of freshwater turtles is scanty. The present study was conducted to address this lacuna in knowledge, which will further aid in identifying threats to the population of freshwater turtles and in devising appropriate methods for their conservation. The diversity and distribution of freshwater turtles was investigated in 186 sites in Goa from June 2012 to May 2015. A total of 337 specimens of two native and one introduced species of freshwater turtles belonging to three families—Trionychidae (Indian Flap-shell Turtle *Lissemys puncata*), Geomydidae (Indian Black Turtle *Melanochelys trijuga*) and Emydidae (Red-eared Slider *Trachemys scripta elegans*)— were identified. *Melanochelys trijuga* (52.23%) was the most widely and abundantly distributed species, and was recorded from 132 sites. *L. punctata* (46.88%) was recorded from 113 sites, while *T. scripta elegans* (0.89%) was rare and was recorded from only two sites. While *Melanochelys trijuga* is generalized in habitat selection, making it the widely distributed species in the State of Goa, *L. punctata* is more specific in habitat selection thus restricting its range to coastal, middle-level plateau and the foothills of Western Ghats.

Keywords: Distribution, diversity, freshwater, Goa, invasive, turtle.

DOI: https://doi.org/10.11609/jott.2835.10.9.12194-12202 | **ZooBank:** urn:lsid:zoobank.org:pub:EDD2A1E7-21C0-4106-B513-08D65ADEE7CB

Editor: Nikhil Whitaker, Madras Crocodile Bank Trust, Mahabalipuram, India. **Date of publication:** 26 August 2018 (online & print)

Manuscript details: Ms # 2835 | Received 11 February 2018 | Final received 29 June 2018 | Finally accepted 20 August 2018

Citation: Jadhav, T.D., N.S. Sawant & S.K. Shyama (2018). Diversity and distribution of freshwater turtles (Reptilia: Testudines) in Goa, India. *Journal of Threatened Taxa* 10(9): 12194–12202; https://doi.org/10.11609/jott.2835.10.9.12194-12202

Funding: Inspire Fellowship-DST, Delhi.

Competing interests: The authors declare no competing interests.

Author Details: Ms. Trupti Jadhav, MSc Zoology, research student, working in the field of ecology, wildlife biology and biodiversity. Dr. Nitin S. Sawant, Assistant Professor, Department of Zoology, working in the field of ecology, wildlife biology, herpetology, biodiversity assessment and environmental conservation. Dr. S.K. Shyama, Professor, Department of Zoology, working in the field of genetic toxicology, environmental mutagenicity, human genetics, ecotoxicology, nanotoxicology.

Author Contribuion: TJ has contributed in the field work and writing of the manuscript; NS has contributed in the field work; SKS has contributed in the final editing of the manuscript.

Acknowledgements: Goa Forest Department, Government of Goa, and Goa University.

Government of India
Department of Science & Technology
Ministry of Science & Technology

inspire

INTRODUCTION

Freshwater turtles are a key component of biodiversity in aquatic ecosystems, aiding other animals and plants by scavenging on dead animals and plants in the aquatic ecosystem. They not only form the major component of freshwater biomass but also participate in the aquatic food web and assists the co-dependent species thus helping in the energentic operation of the ecosystem. Without turtles, aquatic ecosystems would progressively degrade in ways yet to be understood, and would undergo loss of biodiversity (Iverson 1982; Congdon & Gibbons 1989).

Turtles belong to the order Chelonia/Testudines, sub-order Cryptodira of class Reptilia, and comprise of 14 identified families. These include freshwater turtles (Family: Geomydidae and Trionychidae), marine turtles (Family: Cheloniidae and Dermochelyidae), and land tortoises (Family: Testudinidae) (Fritz & Havas 2007). Rhodin et al. (2017) and Stanford et al. (2018) reported 356 living species of turtles and tortoises found in different habitats of the world. India hosts the richest diversity of turtles in the world (Iverson 1992) with 34 species of Chelonians—25 freshwater, five marine, and four land tortoises (Fritz & Havas 2007).

Three species of Testudines, namely, *Nilssonia leithii, Vijayachelys silvatica*, and *Indotestudo travancorica* (tortoise) are endemic to India. *Vijayachelys silvatica* and *Indotestudo travancorica* are endemic to the Western Ghats, whereas *Nilssonia leithii* is endemic to peninsular India (Deepak & Vasudevan 2009). The number of freshwater turtle and tortoise species found in Goa, however, is debatable as some authors (Tikader & Sharma 1985) reported the presence of two species, *Lissemys punctata punctata* and *Melanochelys trijuga trijuga*, in Goa and have stated *Nilssonia leithii* and *Geochelon elegans* to be distributed in peninsular india. Pradhan (2008) reports the presence of four species in Goa: three freshwater species, namely, *Nilssonia leithii, Lissemys punctata punctata*, and *Melanochelys trijuga*, and one tortoise *Geochelone elegans*. Murthy & Das (2009) reported the presence of specimens of two species in the collection of Zoological Survey of India, namely, *Lissemys punctata punctata* and *Melanochelys trijuga trijuga* from few localities in Goa while others (Srivastava & Nigam 2009) reported the presence of only one species in Goa, namely, *Lissemys punctata punctata*.

Studies on freshwater turtle specific to the Goa region are scanty; therefore, baseline data on the existence and distribution of freshwater turtles is deficient. For managing and conserving natural habitats, information on the distribution of a species is imperative (Rubin et al. 1998). The present study was conducted to address this lacuna in knowledge, which will further aid in identifying threats to turtle populations and in devising appropriate methods for their conservation.

MATERIALS AND METHODS

Study Area

Goa is the smallest state in India and is located along its central-west coast (Fig. 1). It is situated at the latitude 15.29932^{0}N and longitude 74.123996^{0}E. The mountainous region of the Sahyadris in the east, the middle-level plateaus in the centre, and the low-lying river basins along with the coastal plains form are the three main physical divisions (Rao 1985–86) of this region. The average rainfall is 2500–3000 mm. The mean daily temperature is around 30^{0}C and the maximum temperature is 36^{0}C. The climate is humid throughout the year, with humidity level ranging from 75%–95% in the monsoon. The main feature of the climate is the southwest monsoon that occurs between June and September. Champion & Seth (1968) classified the major forest types of Goa into west coast tropical evergreen, west coast semi-evergreen, and southern moist deciduous forest.

Methods

Potential sites (rivers, wetlands, streams, ponds, agricultural lands, and forest areas) were visited and transect walks were carried out to observe turtles in the wild throughout the geographical region of Goa; 186 sites (Table 1) were surveyed across Goa as shown in Fig. 1. The sites were randomly selected and were readily accessible. The study was conducted from June 2012 to May 2015 across seasons (summer: March–May, monsoon: June–August, post-monsoon: September–November, and winter: December–February) following the methodology of Akbar et al. (2006). Active searches in the undergrowth were carried out using visual encounter method (Litzgus & Mousseau 2004). Basking turtles were observed and directly counted. Dip net was used for the capture of turtles (Spinks et al. 2003). Netted animals were counted, their species identified, and then released back into the same water. All freshwater turtles encountered during the study were identified up to species level following Smith (1933), Tikader & Sharma (1985), and Das (1985, 2008). The exact location and altitude of the area were recorded using GPS (geographical positioning system) to depict the pattern of distribution of freshwater turtles.

Potentially suitable habitats were also identified. In sites where no turtles were captured or encountered, it was assumed that the site had no turtles or that they occurred at very low densities (Lin et al. 2010). Turtles captured opportunistically by local volunteers were also considered.

The distribution of all three species in seven different habitats was tested using two-way ANOVA. The seasonal encounter of the three species across seasons (summer, monsoon, post-monsoon, and winter) was tested using two-way ANOVA. A difference of $p<0.05$ was regarded as statistically significant. All the calculations were carried out using Microsoft Excel 2010.

RESULTS

During the survey conducted from June 2012 to May 2015, a total of 337 individuals (334 individuals of native species and three individuals of introduced species) of three species of freshwater turtles belonging to three families, viz., Trionychidae (Indian Flap-shell Turtle *Lissemys puncata*), Geomydidae (Indian Black Turtle *Melanochelys trijuga*) and Emydidae (the invasive Red-eared Slider *Trachemys scripta elegans*) were recorded. *Melanochelys trijuga* (Image 1) was the most abundant species and comprised of 52.23% (n=176) of the total individuals encountered, followed by *L. punctata* (Image 2) comprising of 46.88% (n=158), and *T. scripta elegans* (Image 3) comprising of 0.89% (n=3).

Of the 186 sites surveyed, freshwater turtles were encountered at 181 sites. *Melanochelys trijuga* was the

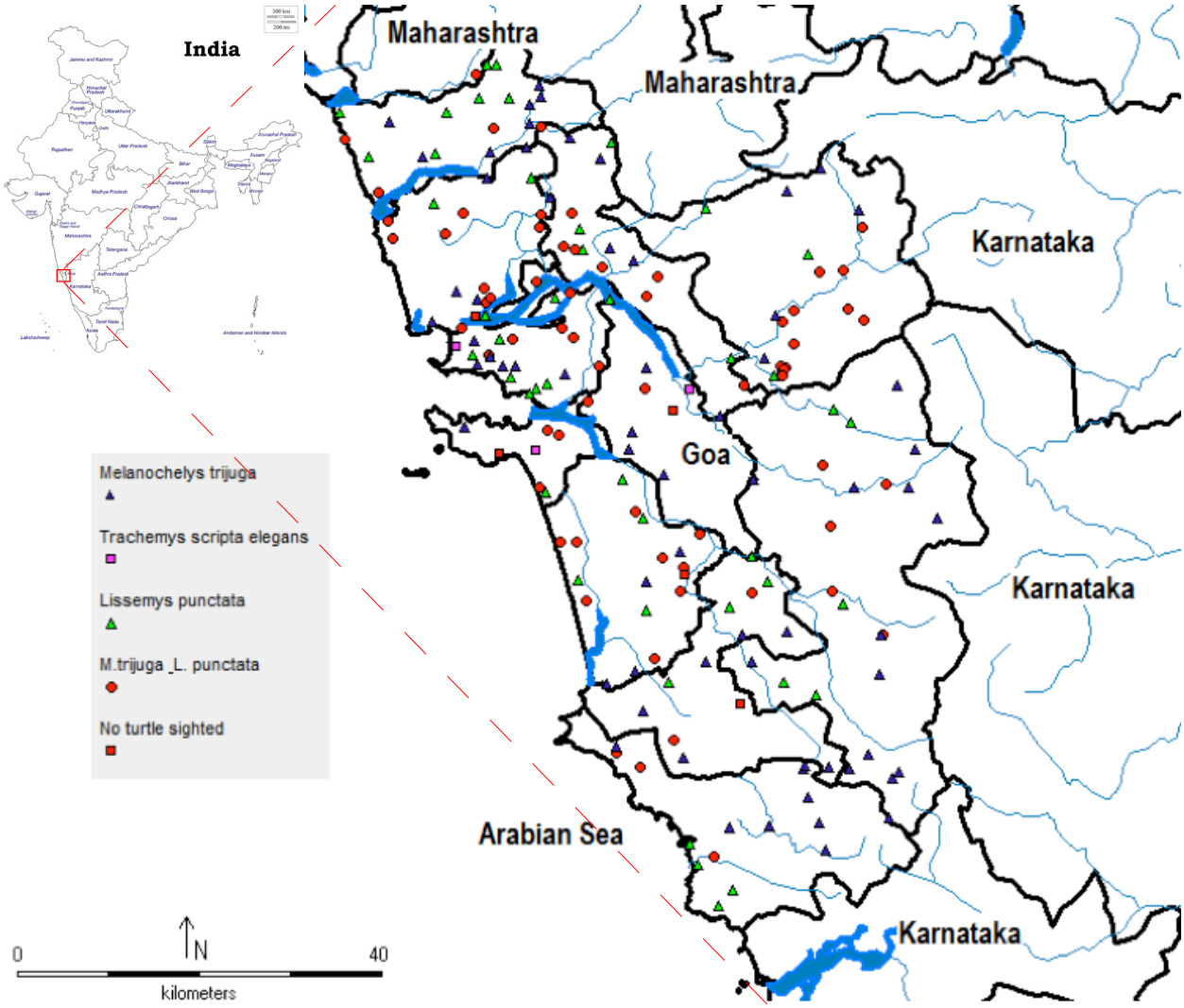

Figure 1. Map of Goa, India, showing the distribution of *Melanochelys trijuga*, *Lissemys punctata*, and *Trachemys scripta elegans*

Image 1. *Melanochelys trijuga*

Image 2. *Lissemys punctata*

Image 3. *Trachemys scripta elegans*

most widely distributed species and was recorded from 132 sites, followed by *L. punctata*, which was reported from 113 sites, and *T. scripta elegans*, which was rare and was reported from only three sites. At 67 sites both *M. trijuga* and *L. punctata* were recorded (Fig. 1).

It was observed that freshwater turtles exhibit nocturnal habits and are active mostly during night, dusk, and dawn. A few individuals were also found while crossing the road. During the day hours, they mostly remain submerged in water, bury themselves in soil, or stay hidden in crevices and moist leaf litter. It was observed that *M. trijuga* was distributed throughout the state of Goa. *L. punctata* was recorded in all terrains except rocky habitats and mountainous regions (Western Ghats). *Melanochelys trijuga* was recorded in slow- and fast-moving rivers and ditches at low and high elevations, in wetlands, agricultural lands, ponds and streams on plains, plateaus, and mountainous areas, and in artificial drainages in urban areas. *L. punctata* was encountered in slow-moving waters, wetlands, agriculture lands, ponds, and streams on plains. *Trachemys scripta elegans* was encountered in a pond (Taleigao, Tiswadi Taluka), a residential area (Upasnagar, Marmugoa Taluka), and in a river (Khandepar, Ponda Taluka). The number of turtles of all the three species found in different habitat types is given in Fig. 2. ANOVA showed that the distribution of freshwater turtles in different habitats was highly significant (df=12, F=4.23, p=0.00024).

Distribution of turtles varied with seasons. During monsoon they were encountered at all 180 sites, whereas in summer and winter they were observed at only 50 and 72 sites, respectively. The highest number of individuals was encountered during monsoon season (Fig. 3). ANOVA showed that the encounter of freshwater turtles varied significantly with seasons (df=6, F=1.44, p=0.24).

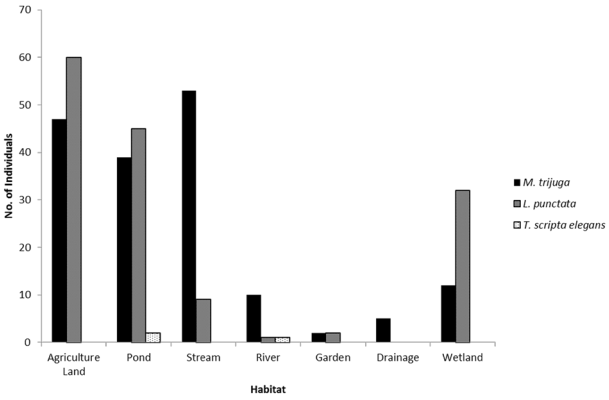

Figure 2. Graph showing the total number of individuals of *Melanochelys trijuga, Lissemys punctata*, and *Trachemys scripta elegans* found in different habitat types

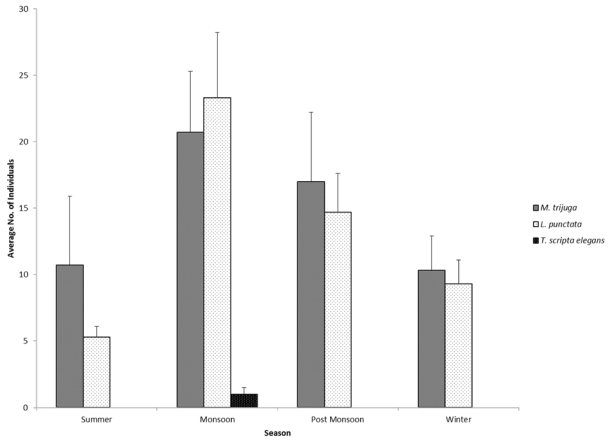

Figure 3. Graph showing the total number of individuals of *Melanochelys trijuga, Lissemys punctata*, and *Trachemys scripta elegans* during different seasons

DISCUSSION

Reptile species inhabit distinct microhabitats and are not randomly distributed in space (Heatwole 1982). The findings with respect to the two native species augment to that of Murthy & Das (2009) and Tikader & Sharma (1985). The presence of *Nilssonia leithii*, however, was not reported during the present study. The presence of *T. scripta elegans* was recorded for the first time in the state of Goa. Trachemys scripta elegans a native of Mississippi Valley area (Pendlebury 2006) was imported to other countries in pet trade (Pendlebury 2006), which eventually led to illegal trade (Pupins 2007). Its impact on the native turtle species in Goa, however, needs to be investigated.

It was observed that *M. trijuga* and *L. punctata* were widely distributed and occupied all potential habitats (agricultural fields, ponds, wetlands, gardens, drainages, rivers, and streams) across the State of Goa. Similar habitats were reported by Tikader & Sharma (1985) for both the species and by Hoassain et al. (2008) for *L. punctata*. *Lissemys punctata*, however, was not reported from the hilly areas of the Western Ghats during the present study and *M. trijuga* occupied all the possible habitats, including drainages, in the urban setup. *M. trijuga* was found to be the most abundant species (52.22%), followed by *L. punctata* (46.88%) and *T. scripta elegans*, which was the rarest (0.89%). *Lissemys punctata* preferred agricultural fields (37.97%), ponds (28.48%), and wetlands (20.25%), and was rarely sighted in streams (5.69%), gardens (1.27%), and rivers (0.63%).

Table 1. List of Site and habitat surveyed; Road*- Indicates road passing through paddy fields; Road# - Indicates road passing through forests; Road@ - Indicates road passing through wetland; '□' Indicates sites where no turtles were encountered

Taluka / Site No.	Name of Locality	Habitat	Latitude	Longitude
Pernem				
1	Korgao	Pond	15°42'28.94"N	73°45'11.83"E
2	Chandel	Wetland	15°43'39.30"N	73°53'49.57"E
3	Kondalwada	Pond	15°42'41.26"N	73°4814.66"E
4	Tuvem	Agriculture land	15°40'9.92"N	73°47'35.01"E
5	Mandrem	Wetland	15°40'2.13"N	73°43'32.34"E
6	Morjim	Agriculture land	15°37'53.80"N	73°44'5.15"E
7	Parse	Pond	15°37'52.55"N	73°44'3.75"E
8	Dadachiwadi	Stream	15°41'45.93"N	73°50'59.66"E
9	Hasapur	Pond	15°44'21.3"N	73°53'54.71"E
10	Harmal	Wetland	15°41'2.32"N	73°42'32.95"E
11	Vadnem	Drainage	15°43'7.39"N	73°53'13.54"E
12	Varkhand	Stream	15°43'31.90"N	73° 50'7.00"E
13	Ugvem	Agriculture land	15°44'57.55"N	73°56'0.40"E
14	Keri	Pond	15°42'57.55"N	73°49'57.78"E
16	Vajri	River	15°42'3.14"N	73°53'9.26"E
16	Mopa	Agriculture land	15°45'30.75"N	73°51'13.38"E
17	Tamboxem	Road*	15°45'30.51"N	73° 56'38.02"E
18	Shemecheadvan	Agriculture land	15°43'37.24"N	73°56'59.07"E
19	Dhargal	Pond	15°40'19.08"N	73°50'46.90"E
Bardez				
20	Kanka	Agriculture land	15°35'26.98"N	73°48'09.97"E
21	Kuchelim	Stream	15°36'40.91"N	73°49'09.46"E
22	Quitla	Agriculture land	15°32'09.33"N	73°50'26.80"E
23	Pilern	Road@	15°32'00.22"N	73°48'49.26"E
24	Revora	Wetland	15°39'24.44"N	73°50'38.67"E
25	Porvorim	Drainage	15°31'31.90"N	73°50'05.01"E
26	Haliwada	Stream	15°31'18.01"N	73°50'32.14"E
27	Virlosa	Agriculture land	15°30'37.38"N	73°50'31.62"E
28	Badem	Pond	15°31'39.09"N	73°50'47.85"E
29	Shivolim	Road*	15°37'16.12"N	73°47'27.65"E
30	Anjuna	Pond	15°35'06.84"N	73°44'57.84"E
31	Caisua	Pond	15°36'14.34"N	73°44'40.85"E
32	Nerul	Stream	15°35'06.84"N	73°44'57.84"E
33	Assagao	Stream□	15°30'26.82"N	73°49'55.67"E
Tiswadi				
34	Shirdona	Wetland	15°26'49.61"N	73°52'03..91"E
35	Carambolim	Wetland	15°29'12.75"N	73°55'47.82"E
36	Malar,Divar	Agriculture land	15°31'40.28"N	73°54'45.87"E
37	Campal	Garden	15°29'50.95"N	73°49'08.24"E
38	Bhatlem	Stream	15°29'02.49"N	73°49'48.56"E
39	Aggasaim	Agriculture land	15°26'08.89"N	73°53'34.08"E
40	St.Cruz	Agriculture land	15°28'09.72"N	73°50'43.29"E
41	Kalapur	Agriculture land	15°28'04.23"N	73°50'48.03"E
42	Carambolim Lake	Wetland	15°29'49.01"N	73°55'07.89"E
43	Amaral Band	Agriculture land	15°28'12.20"N	73°49'43.56"E
44	Taleigao	Agriculture land	15°28'40.20"N	73°48'45.81"E
45	Dongrim	Stream	15°27'02.77"N	73°55'16.96"E
46	Neura	Road*	15°26'26.82"N	73°54'15.13"E
47	Chorao	Agriculture land	15°32'36.11"N	73°53'32.03"E
48	Divar	Pond	15°31'52.79"N	73°55'34.02"E
49	Bambolim	Agriculture land	15°27'33.28"N	73°51'36.93"E
50	Goa Velha	Agriculture land	15°25'36.93"N	73°53'12.37"E
51	Merces	Agriculture land	15°29'10.88"N	73°51'22.53"E
52	Chimbel	Pond	15°29'06.36"N	73°52'08.58"E
53	Curca	Wetland	15°27'32.11"N	73°52'22.42"E
54	Goa University Campus	Road*	15°27'39.18"N	73°50'04.56"E
Bicholim				
55	Mayem	Stream	15°34'29.88"N	73°55'53.02"E
56	Pilgao	Pond	15°33'24.60"N	73°57'30.28"E
57	Kumbharwada, Mayem	Wetland	15°34'38.96"N	73°55'13.78"E
58	Mayem lake	Pond	15°34'30.42"N	73°56'21.11"E
59	Poira	Wetland	15°35'46.46"N	73°53'47.05"E
60	Menkurem	Pond	15°41'51.66"N	73°53'49.47"E
61	Sarvan	Pond	15°34'33.74"N	73°57'58.38"E
62	Navelim	Agriculture land	15°31'41.16 N	74°00'6.80"E
63	Kudnem	Pond	15°32'51.34"N	74°00'51.45"E
64	Sal	Agriculture land	15°41'12.21"N	73°55'34.95"E
65	Latambarcem	Agriculture land	15°39'56.55"N	73°57'06.95"E
66	Pirna	Agriculture land	15°40'33.33"N	73°52'59.62"E
67	Advalpal	Agriculture land	15°38'47.18"N	73°53'16.97"E
68	Mulgao	Agriculture land	15°36'39.10"N	73°55'38.58"E
69	Asnora	River	15°37'37.07"N	73°54'25.85"E
70	Bordem	Wetland	15°35'42.14"N	73°56'06.69"E
71	Karapur	Pond	15°33'47.68"N	73°59'25.13"E
72	Shirgao	Agriculture land	15°36'18.98"N	73°54'01.94"E
Sattari				

Taluka / Site No.	Name of Locality	Habitat	Latitude	Longitude
73	Kumthal	Stream	15°30′58.20″N	74°12′12.31″E
74	Velge	Road+	15°30′52.62″N	74°08′54.71″E
75	Gulelim	Stream	15°27′17.73″N	74°08′17.41″E
76	Paikul	Pond	15°26′55.16″N	74°07′48.72″E
77	Shel	Pond	15°27′33.53″N	74°08′11.93″E
78	Melaulim	Agriculture land	15°27′24.88″N	74°08′28.23″E
79	Nanus	Road*	15°30′32.55″N	74°44′57.84″E
80	Sheldobar	Pond	15°35′06.84″N	74°07′53.39″E
81	Shel-Dhadyar	Pond	15°27′21.30″N	74°08′22.66″E
82	Paikul (Ragada)	River	15°28′02.37″N	74°07′12.03″E
83	Shel-Melaulim	Pond	15°27′23.33″N	74°08′25.10″E
84	Khotodem	Agriculture land	15°28′49.31″N	74°08′53.62″E
85	Khadki	River	15°30′11.88″N	74°8′13.49″E
86	Bramhakarmali	Wetland	15°34′13.22″N	74°09′46.79″E
87	Sathre	Stream	15°36′54.55″N	74°12′49.42″E
88	Ivrem	Stream	15°38′02.72″N	74°08′52.22″E
89	Surla	Stream	15°39′54.15″N	74°10′18.37″E
90	Derode	Pond	15°35′47.42″N	74°12′59.92″E
91	Caranzole	Pond	15°30′15.65″N	74°13′09.00″E
92	Dhave	Agriculture land	15°33′10.57″N	73°10′28.50″E
93	Ushte	Agriculture land	15°33′16.41″N	74°11′54.68″E
94	Gotelim	Wetland	15°36′55.25″N	74°03′39.90″E
Ponda				
95	Bondla	Pond	15°26′24.70″N	74°06′02.95″E
96	Ganjem	River	15°28′02.22″N	74°05′15.25″E
97	Keri	Agriculture land	15°27′24.62″N	74°00′10.24″E
98	Khandepar	River	15°26′06.19″N	74°02′44.61″E
99	Kundai	Agriculture land	15°27′30.94″N	73°57′19.74″E
100	Usgao	River	15°24′35.98″N	74°04′33.07″E
101	Talaulim	Road*	15°22′39.16″N	73°59′02.06″E
102	Kavale	Stream	15°23′37.65″N	73°59′17.33″E
103	Dabal	Stream	15°20′47.49″N	74°06′35.17″E
104	Palem	Agriculture land	15°21′03.89″N	74°01′13.26″E
105	Madkai	Agriculture land	15°25′25.63″N	73°56′39.30″E
106	Priol	Stream	15°26′11.07″N	74°00′02.64″E
107	Khandola	Agriculture land	15°31′31.57″N	73°57′56.04″E
108	Borim	Pond	15°21′03.99″N	74°01′12.67″E
109	Kurti	Agriculture land□	15°24′49.50″N	73°01′49.25″E
Marmugoa				
110	Upasnagar	Pond	15°22′25.67″N	73°53′33.12″E
111	Vasco	Road@	15°23′52.08″N	73°49′15.57″E
112	Casaulim	Wetland	15°20′19.25″N	73°53′45.35″E

Taluka / Site No.	Name of Locality	Habitat	Latitude	Longitude
113	Arrosim	Wetland	15°20′00.63″N	73°54′07.05″E
114	Issorcim	Wetland□	15°22′14.80″N	73°51′31.74″E
115	Cortalim	Agriculture land	15°23′25.95 N	73°54′53.96″E
116	Sancoale	Pond	15°23′42.92″N	73°54′14.95″E
Dharbandora				
117	Sonaulim	River	15°18′44.10″N	74°17′49.86″E
118	Sacordem	Agriculture land	15°24′58.82″N	74°11′17.93″E
119	Campsite, Mollem	River	15°20′29.09″N	74°15′08.66″E
120	Satpal	Agriculture land	15°24′10.87″N	74°12′21.78″E
121	Sunset point, Mollem	Stream	15°24′13.47″N	74°15′59.32″E
122	Tambdisurla	Stream	15°26′23.20″N	74°15′08.97″E
123	Collem	Pond	15°20′27.26″N	74°14′28.46″E
124	Shigao	Agriculture land	15°20′17.10″N	74°12′32.50″E
Salcete				
125	Varca	Agriculture land	15°13′28.04″N	73°56′29.37″E
126	Betul	Stream	15°08′32.65″N	73°57′48.54″E
127	Velim	Agriculture land	15°09′24.51″N	73°58′03.25″E
128	Maina-Curtorim	Wetland	15°16′05.46″N	74°01′04.76″E
129	Raia	Pond	15°18′51.85″N	73°59′30.52″E
130	Rachol	Pond	15°18′26.45″N	74°06′00.96″E
131	Chandor	Agriculture land	15°15′28. 48″N	74°02′21.49″E
132	Caurim	Agriculture land□	15°14′59.31″N	74°02′26.62″E
133	Guirdolim	Road*	15°16′28.16″N	74°02′12.04″E
134	Loutolim	Road*	15°20′42.98″N	73°58′44.96″E
135	Seraulim	Pond	15°17′01.40″N	73°55′57.34″E
136	Macazana	Agriculture land	15°17′28.01″N	74°03′18.00″E
137	Sao Jose De Areal	Stream	15°14′38.23″N	74°00′08.19″E
138	Colva	Wetland	15°17′10.32″N	73°54′58.20″E
139	Benaulim	Pond	15°14′45.93″N	73°56′03.82″E
140	Sarzora	Road*	15°12′57.50″N	74°00′07.20″E
Sanguem				
141	Verle	Agriculture land	15°02′48.24″N	74°14′50.73″E
142	Kalem	Pond	15°17′57.12″N	74°11′09.72″E
143	Ugem	Pond	15°14′04.96″N	74°11′10.70″E
144	Bhati	Pond	15°11′30.56″N	74°14′11.98″E
145	Savordem	Road*	15°11′09.33″N	74°06′27.15″E
146	Valkini	Agriculture land	15°13′18.81″N	74°11′50.65″E
147	Savri	Stream	15°04′20.38″N	74°13′24.70″E
148	Tudov	Stream	15°03′34.55″N	74°15′15.76″E
149	Saljini	Stream	15°00′30.99″N	74°14′40.96″E

Taluka / Site No.	Name of Locality	Habitat	Latitude	Longitude
150	Nundem	Stream	15°32′07.67″N	74°12′06.41″E
151	Rivona	Stream	15°09′52.89″N	74°06′29.21″E
152	Curpe	Agriculture land	15°07′53.07″N	74°10′14.37″E
153	Colomb	Agriculture land	15°08′35.76″N	74°08′23.52″E
154	Sangod	Agriculture land	15°21′36.38″N	74°10′40.83″E
155	Shigone	Pond	15°09′05.70″N	74°14′03.47″E
156	Naiquini	Agriculture land	15°11′32.61″N	74°14′16.52″E
Quepem				
157	Bali	Stream	15°08′36.31″N	74°01′28.68″E
158	Shirvoi	Agriculture land	15°11′29.42″N	74°05′52.90″E
159	Morpirla	Stream	15°06′55.07″N	73°59′56.07″E
160	Paroda	Pond	15°14′01.78″N	74°02′11.43″E
161	Fatorda	Wetland	15°09′20.26″N	73°59′30.85″E
162	Kunkolim	Agriculture land	15°10′03.75″N	74°00′35.62″E
163	Maina	Agriculture land□	15°07′18.35″N	74°05′45.78″E
164	Tilamol	Agriculture land	15°13′04.36″N	74°05′07.62″E
165	Cacora	Road*	15°14′39.30″N	74°07′22.86″E
166	Curchorem	Road*	15°13′56.64″N	74°06′29.00″E
167	Cavrem	Stream	15°09′52.99″N	74°04′05.47″E
168	Padi	Agriculture land	15°05′11.34″N	74°01′44.48″E
169	Mangal	Agriculture land	15°03′34.15″N	74°11′03.71″E
170	Barcem	Stream	15°04′11.83″N	74°02′19.83″E
171	Molkornem	Stream	15°11′42.07″N	74°08′31.60″E
Canacona				
172	Aave	Stream	15°01′44.86″N	73°09′47.95″E
173	Eda	Stream	15°00′13.06″N	74°10′27.06″E
174	Agonda	Agriculture land	15°02′59.68″N	73°59′46.54″E
175	Shirtvoti, Khola	Stream	15°04'43.03''N	73°58'33.06''E
176	Khola	Stream	15°04′49.24″N	73°58′16.55″E
177	Loliem	Agriculture land	14°56′13.10″N	74°05′20.46″E
178	Galgibag	Wetland	14°58′16.49″N	74°04′08.04″E
179	Talpan	Pond	14°59′02.69″N	74°02′42.52″E
180	Dhantali	Stream	14°58′34.71″N	74°10′51.90″E
181	Bamanbudo	Stream	15°03′28.88″N	74°09′29.47″E
182	Ambeghat	Road#	15°03′40.53″N	74°09′37.16″E
183	Mashem	Wetland	14°57′47.02″N	74°03′15.04″E
184	Bhatpal	River	14°59′55.26″N	74°05′09.26″E
185	Gaodongrim	Stream	15°00′32.89″N	74°07′31.68″E
186	Polem	Pond	14°55′15.92″N	74°04′25.47″E

No individuals of *L. punctata* were found in drainages. The highest encounters of *L. punctata* were in agricultural fields and the lowest were in rivers and gardens. This suggests that *L. punctata* prefers marshy areas and stagnant waters that might assist in burrowing, which provides protection from predators. This also elucidates their absence in hilly regions where the stream beds consist mostly of pebbles and rocks that possibly will not serve as good refuge grounds. Hossain et al. (2008) reported that marshlands and agricultural fields were the most preferred habitats of *L. punctata*, followed by ponds, streams, and lakes.

On the contrary, *M. trijuga* preferred streams (30.11%), agricultural lands (26.7%), and ponds (22.16%) followed by wetlands (6.81%), rivers (5.68%), drainages (2.84%), and gardens (1.14%). This suggests that *M. trijuga* can acclimatize to all habitat types. The distribution of all the three species in different habitats was highly significant.

The encounter of freshwater turtles in different seasons was significant when tested statistically. Highest numbers of individuals were encountered in monsoon and post-monsoon season, which may be attributed to favorable climatic conditions and rich prey base, as compared to summer and winter, when the resources required for survival are limited, thus restricting the distribution of species. Similar observations were made in other groups of reptiles such as snakes by Sawant et al. (2010). Thus, the present study reports the presence of three species of freshwater turtles in Goa, namely, *M. trijuga, L. punctata*, and *T. scripta elegnas*. *Melanochelys trijuga* is generalized in habitat selection thus making it the most widely distributed species in the state of Goa and *L. punctata* is more specific in habitat selection thus restricting its range to coastal, middle-level plateau, and foothills of Western Ghats.

REFERENCES

Akbar, M., M. Mushtaq-ul-Hassan & Z. Nisa (2006). Distribution of freshwater turtles in Punjab, Pakistan. *Caspian Journal of Environmental Science* 4(2): 142–146.

Champion, H.G. & S.K. Seth (1968). *A Revised Survey of the Forest Types of India*. Government of India Press, New Delhi, xxvii+404pp.

Congdon, J.D. & J.W. Gibbons (1989). Biomass productivity of turtles in freshwater wetlands: a geographic comparison, pp. 583–591. In: Sharitz, R.R. & J.W. Gibbons (eds.). F*reshwater Wetlands and Wildlife*. U.S. Department of Energy Symposium Series 61, Oak Ridge, 1265pp.

Das, I. (1985). *Indian Turtles: A Field Guide*. World Wide Fund for Nature-India, Calcutta, 119pp.

Das, I. (2008). *A Photographic Guide to Snakes and other Reptiles of India*. Om Books International, New Delhi, 144pp.

Deepak, V. & K. Vasudevan (2009). Endemic turtles of India, pp. 25–42. In: Vasudevan, K. (ed.). F*reshwater Turtles and Tortoises of India*.

ENVIS Bulletin: Wildlife and Protected Areas Vol. 12(1). Wildlife Institute of India, Dehradun, 177pp.

Fritz, U. & P. Havas (2007). Checklist of Chelonians of the world. *Vertebrate Zoology* 57(2): 149–368.

Heatwole, H. (1982). A review of structuring in herpetofaunal assemblages, pp. 1–19. In: Scott, N.J., Jr. (ed.). *Herpetological Communities: A Symposium of the Society for the Study of Amphibians and Reptiles and the Herpetologists' League*. Fish and wildlife service, United States, 239pp.

Hossain, L., S.U. Sarker & N.J. Sarker (2008). Ecology of Spotted Flapshell Turtle, *Lissemys punctata* (Lacepede, 1788) in Bangladesh. *Ecoprint* 15: 59–67.

Iverson, J.B. (1982). Biomass in turtle populations: A neglected subject. *Oecologia* 55(1): 69–76.

Iverson, J.B. (1992). *A Revised Checklist with Distribution Maps of The Turtles of The World*. Privately Printed, Richmond, Indiana, 363pp.

Lin, Y., S. Wu, T. Lin, J. Mao & T. Chen (2010). Population status and distribution of the Endangered Yellow-margined Box Turtle Cuora flavomarginata in Taiwan. *Oryx* 44(4): 581–587; https://doi.org/10.1017/S0030605310000797

Litzgus, J.D. & T.A. Mousseau (2004). Demography of a southern population of the Spotted Turtle (*Clemmys guttata*). *Southeastern Naturalist* 3(3): 391–400.

Murthy, B.H.C. & I. Das (2009). The turtle collection of the Zoological Survey of India, Kolkata, India, pp. 15–24. In: Vasudevan, K. (ed.). Freshwater turtles and tortoises of India. ENVIS Bulletin: Wildlife and Protected Areas vol. 12(1). Wildlife Institute of India, Dehradun, 177pp.

Pendlebury, P. (2006). *Trachemys scripta elegans* (reptile). Invasive Species Specialist Group. http://www.issg.org/database/species/ecology.asp?si=71&fr=1&sts

Pradhan, M.S. (2008). Reptilia, pp. 281–364. In: Director (ed.). Fauna of Goa, State Fauna Series 16. Zoological Survey of India, Kolkata, 531pp.

Pupins, M. (2007). First report on recording of the invasive species Trachemys scripta elegans, a potential competitor of Emys orbicularis in Latvia. Acta Universitatis Latviensis 723: 37–46.

Rao, R.S. (1985–86). Flora of Goa, Diu, Daman, Dadra and Nagarhaveli, Vol. 1 & 2. Botanical Survey of India, Calcutta, 546pp.

Rhodin, A.G.J., J.B. Iverson, R. Bour, U. Fritz, A. Georges, H.B. Shaffer & P.P. van Dijk (2017). Turtles of the world: Annotated checklist and atlas of taxonomy, synonymy, distribution, and conservation status (8th Ed.), pp. 1–292. In: Rhodin, A.G.J., J.B. Iverson, P.P. van Dijk, R.A. Saumure, K.A. Buhlmann, P.C.H. Pritchard & R.A. Mittermeier (eds.). Conservation Biology of Freshwater Turtles and Tortoises: A Compilation Project of the IUCN/SSC Tortoise and Freshwater Turtle Specialist Group. Chelonian Research Monographs 7.;

Rubin, E.S., W.M. Boyce, M.C. Jorgensen, S.G. Torres, C.L. Hayes, C.S. O'Brien & D.A. Jessup (1998). Distribution and abundance of Bighorn sheep in the Peninsular Ranges. California Wildlife Society Bulletin 26(3): 539–551.

Sawant, N.S., T.D. Jadhav & S.K. Shyama (2010). Distribution and abundance of pit vipers (Reptilia: Viperidae) along the Western Ghats of Goa, India. *Journal of Threatened Taxa* 2(10): 1199–1204; https://doi.org/10.11609/JoTT.o2489.1199-204

Smith, M.A. (1931). *The Fauna of British India including Ceylon and Burma: Reptilia and Amphibia. Vol. 1. Loricata, Testudines*. Taylor and Francis, London (Reprinted 1974, 1995 by Today and Tomorrow's Printers and Publishers, New Delhi), xxviii+185pp.

Spinks, P.Q., G.B. Pauly, J.J. Crayon & H.B. Shaffer (2003). Survival of the Western Pond Turtle (*Emys marmorata*) in an urban California environment. Biological Conservation 113: 257–267.

Srivastav, A. & P. Nigam (2009). Freshwater turtles of India: Status and management in captivity, pp. 133–141. In: Vasudevan, K. (ed.). *Freshwater Turtles and Tortoises of India*. ENVIS Bulletin: Wildlife and Protected Areas vol. 12(1). Wildlife Institute of India, Dehradun, 177pp.

Stanford, C.B., A.G.J. Rhodin, P.P. van Dijk, B.D. Horne, T. Blanck, E.V. Goode, R. Hudson, R.A. Mittermeier, A. Currylow, C. Eisemberg, M. Frankel, A. Georges, P.M. Gibbons, J.O. Juvik, G. Kuchling, L. Luiselli, H. Shi, S. Singh & A. Walde (eds.) (2018). *Turtles in Trouble: The World's 25+ Most Endangered Tortoises and Freshwater Turtles*. Turtle Conservation Coalition, Ojai, 79pp.

Tikader, B.K. & R.C. Sharma (1985). *Handbook of Indian Testudines*. Zoological Survey of India, Calcutta, 156pp.

Journal of Threatened Taxa

www.threatenedtaxa.org

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

August 2018 | Vol. 10 | No. 9 | Pages: 12147–12298
Date of Publication: 26 August 2018 (Online & Print)
DOI: 10.11609/jott.2018.10.9.12147-12298