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To Cite:
Pamulapati P, Sulthana SR, Jaiswal D. Diversity and distribution of non-marine malacofauna from tiger reserves of Telangana, India. *Species* 2024; 25: e32s1689
doi: https://doi.org/10.54905/disssi.v25i76.e32s1689

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Peer-Review History
Received: 15 April 2024
Reviewed & Revised: 19/April/2024 to 24/June/2024
Accepted: 27 June 2024
Published: 03 July 2024

Peer-Review Model
External peer-review was done through double-blind method.

Species
pISSN 2319–5746; eISSN 2319–5754

DISCOVERY
SCIENTIFIC SOCIETY

Diversity and distribution of non-marine malacofauna from tiger reserves of Telangana, India

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ABSTRACT

Mollusca is remarkably one of the most diverse animal groups. Despite this fact, knowledge of the diversity and distribution of these species is still lagging in Telangana state, India. Hence, the present study aimed to study the malacofaunal diversity at different stations of two tiger reserves of Telangana to fill the gaps in the existing knowledge. Altogether, 37 sampling stations were surveyed for three years, from 2020 to 2022 in the present investigation. A total of 66 species of non-marine molluscs were recorded, including 33 land species and 33 freshwater species.

Keywords: Malacofauna, freshwater molluscs, terrestrial molluscs, Tiger Reserves, Telangana

1. INTRODUCTION

Inventory of species or baseline studies is crucial for biodiversity management and understanding the diversity patterns of species. In this paper, we present a first inventory of non-marine malacofauna from the tiger reserves of Telangana. Mollusca is one of the most speciose and heterogeneous groups of organisms occupying comprehensive habitats. Mollusca play a vital role in the dynamics of an ecosystem and provide ecological and nutritional benefits (Dunk et al., 2004; Deepak et al., 2009). They are valuable subjects for researchers in fields ranging from ecology, evolutionary, biogeography to conservation biology (Richards and Davison, 2010). They are sensitive to the environment and thus used in biomonitoring on heavy metal pollution, microplastic pollution, etc. Some malacofaunal species, such as *Lissachatina fulica,* are severe agricultural pests Baker, (2002), and some serve as intermediary hosts. It is imperative to have a regional inventory of non-marine molluscs for addressing environmental issues, safeguarding public health, and understanding the region's biodiversity.

2. MATERIAL AND METHODS

Study location

Telangana state is blessed with 12 protected areas comprising two tiger reserves, *viz.*, Amrabad tiger reserve and Kawal tiger reserve. Amrabad Tiger Reserve (16°00′N to 16°34′N and 78°24′E to 79°19′E) is situated in the Nagarkurnool district in the southern part of Telangana on the north bank of river Krishna. It has 2611.37 sq. km of core area and 445.02 sq. km of buffer area. It is the second-largest tiger reserve in India in terms of core area. It was designated a sanctuary in 1983. After the partition of Andhra Pradesh state in 2014, the part of Nagarjunsagar-Srisailam Tiger Reserve located in Telangana is named Amrabad Tiger Reserve. It has 3 divisions Amrabad, Achampet and Nagarjuna Sagar. Amrabad Tiger Reserve, a part of the Nallamala forest, is bestowed with diverse habitats such as caves, waterfalls, grasslands, hills, and valleys. It has dry deciduous and moist deciduous forest types and is an Important Bird Area.

Kawal Wildlife Sanctuary (18º40′ and 19º56′ N and 77º46′ and 80º0′ E) was declared as a tiger reserve in April 2012 with a core zone of 898.23 sq. km and buffer area of 1123.21 sq. km. It is spread over Adilabad, Asifabad, Mancherial, and Nirmal districts in the northern part of Telangana. It has dry deciduous forest types with much of teak plantation. It has diverse aquatic habitats with rivers, streams and stagnant water bodies. Sahyadri mountain ranges are also present. Kadem, a tributary of river Godavari flows through this area. It has six ranges *viz.*, Pembi, Kaddam, Jannaram, Indanpally, Birsaipet, Tadlapet.

Methodology

Samples were collected from 37 selected stations of two tiger reserves (Table 1 and Table 2; Figure 1) between 7 and 10 am following visual and tactile search methods (Cummings et al., 2016). Sampling stations surveyed in Amrabad (16 stations) and Kawal tiger reserve (21 stations) are shown in (Figures 2 and 3). Freshwater molluscs were collected by either handpicking simply or with the help of nets. Terrestrial snails are carefully searched in the possible habitats and hand-collected. The specimens were taken in plastic containers and narcotized.

After getting rid of mucous and dirt, they were fixed in ascending grades of alcohol and preserved in 70% ethanol. Specimens were identified using standard literature (Preston, 1915; Rao, 1989; Ramakrishna and Dey, 2007, Gude, 1914; Vaught et al., 1989; Mitra et al., 2005; Raheem et al., 2014). The validity of each species was confirmed with virtual database-WoRMS (World Register of Marine Species). Identified species were labelled and deposited in the National Zoological Collection in Freshwater Biology Regional Centre, Zoological Survey of India, Hyderabad, Telangana, India.

Table 1 Sampling locations at Amrabad Tiger Reserve

S.No.	Locality	State	Latitude	Longitude
1	Rangapoor	Telangana	16°23′38.5″ N	78°44′15.0″ E
2	Mannanuru	Telangana	16°19′12″ N	78°44′44″ E
3	Mallelatheertham waterfall	Telangana	16°16′02.0″ N	78°51′21.9″ E
4	Farhabad gate	Telangana	16°15'22" N	78°40'17" E
5	Vatavarlapally forest	Telangana	16°14'06" N	78°47'17" E
6	Octopus viewpoint	Telangana	16°13′22.5″ N	78°49′53.9″ E
7	Krishna river near Akka Mahadevi	Telangana	16°9'22.4" N	78°50' 7.5" E
8	Base camp near Domalapenta	Telangana	16°12'36" N	78°49'31" E
9	Domalapenta	Telangana	16°11′24″ N	78°49′31.44″ E
10	Vatavarlaplly pond, Domalapenta	Telangana	16°15'05" N	78°45'41" E
11	Farhabad viewpoint	Telangana	16°15' 24" N	78°40'18" E
12	Umamaheswaram	Telangana	16°16'01" N	78°51'26" E

13	Loddi Mallanna waterfall	Telangana	16°18′18″ N	78°43′14″ E
14	Saleshwaram waterfall	Telangana	16°10′11″ N	78°38′21″ E
15	B.K.Thirumalapur, Amrabad	Telangana	16°33′29″ N	78°90′73″ E
16	Maddimadugu, Amrabad	Telangana	16°31′19″ N	79°17′10″ E

Table 2 Sampling locations at Kawal Tiger Reserve

S.No.	Locality	State/UT	Latitude	Longitude
1	Kumram bheem reservoir	Telangana	19°24'22'' N	79°13'53'' E
2	Rotiguda vagu	Telangana	19°05'15'' N	79°04'43'' E
3	Buggaguda,	Telangana	19°15′31.4″ N	79°10′40.0″ E
4	Haritha Resort, Kadam	Telangana	19°10′15″ N	78°77′84″ E
5	Solar peti	Telangana	19°07′34.5″ N	79°05′58.2″ E
6	Savathula gundam waterfalls	Telangana	19°18' 33'' N	79°05'37'' E
7	Pulgampandri	Telangana	19°27'06'' N	78°58'17'' E
8	Indanpally	Telangana	-	-
9	Stream near Kalleda	Telangana	19°09'01'' N	78°51'52'' E
10	Kadem Dam	Telangana	19° 5' 52.8'' N	78° 48' 18'' E
11	Godavari river, Oblapur	Telangana	19°00'36" N	78°39'56" E
12	Pathatharlapdu	Telangana	19°05'19" N	78°37'50" E
13	Mathadiguda	Telangana	19°22′89″ N	78°48′36″ E
14	Udampur	Telangana	19°12′15″ N	78°52′35.2″ E
15	Pond near Udampur	Telangana	19°11′52″ N	78°53′12″ E
16	Gangapur road side, Kadem	Telangana	19°08′45″ N	78°48′34″ E
17	Stream near Pulgampandri	Telangana	19°14'53" N	78°35'29" E
18	Kunthala waterfall	Telangana	19°17′05″ N	78°30′11″ E
19	Pochera waterfall	Telangana	19°20′34″ N	78°23′13″ E
20	Forest near Laxmipur	Telangana	19°8' 44.16'' N	78°48'32.76'' E
21	Stream near Morrigudem	Telangana	19°08′05.1″ N	78°57′34.2″ E

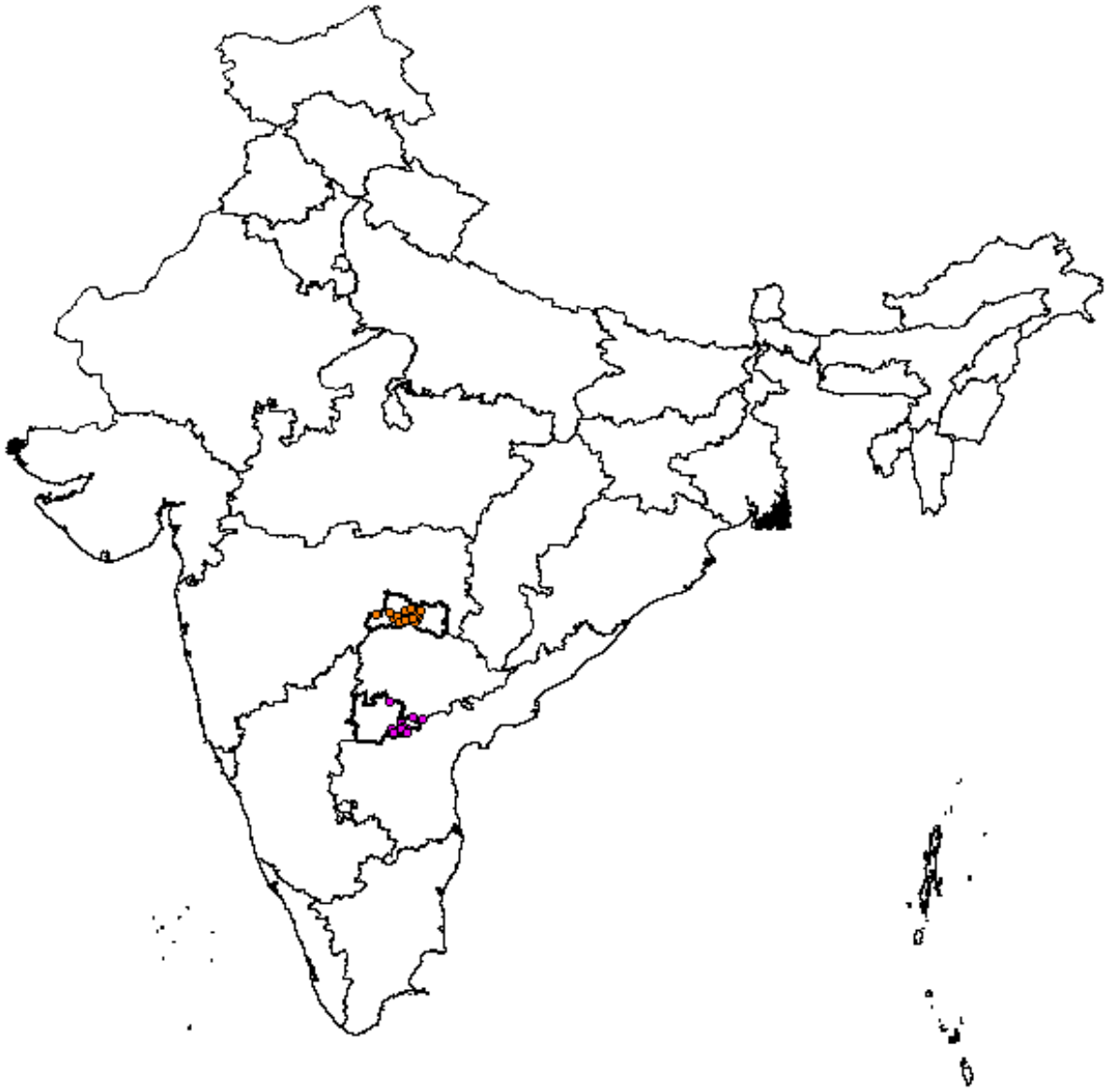


Figure 1 Sampling sites at tiger reserves of Telangana (sites mentioned in Orange & Violet color)

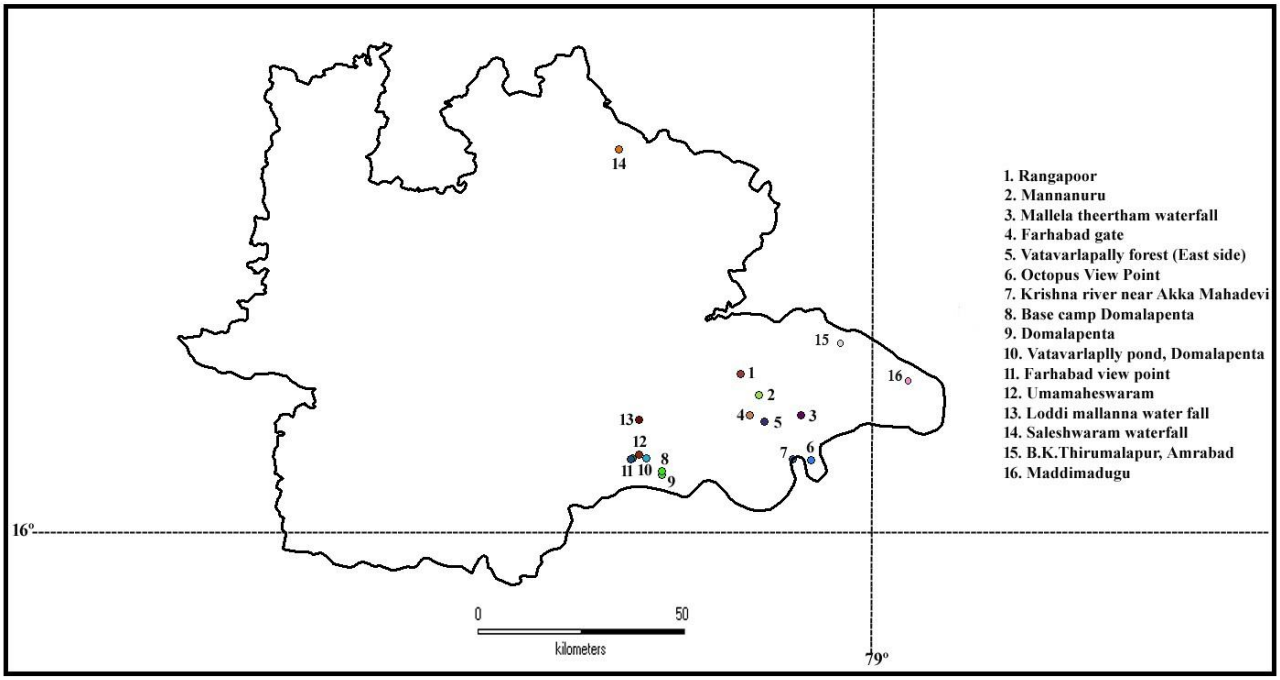


Figure 2 Sampling sites at Amrabad Tiger Reserve of Telangana

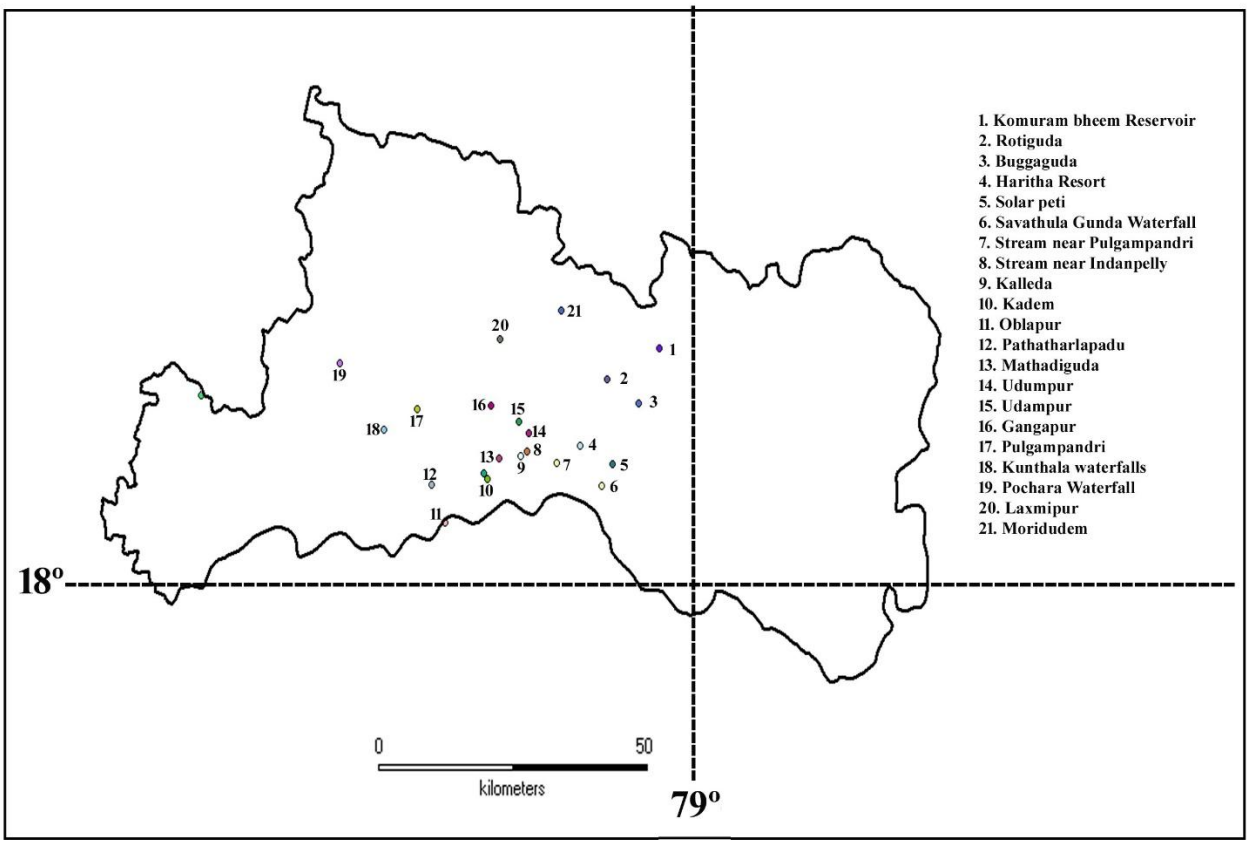


Figure 3 Sampling sites at Kawal Tiger Reserve of Telangana

3. RESULTS

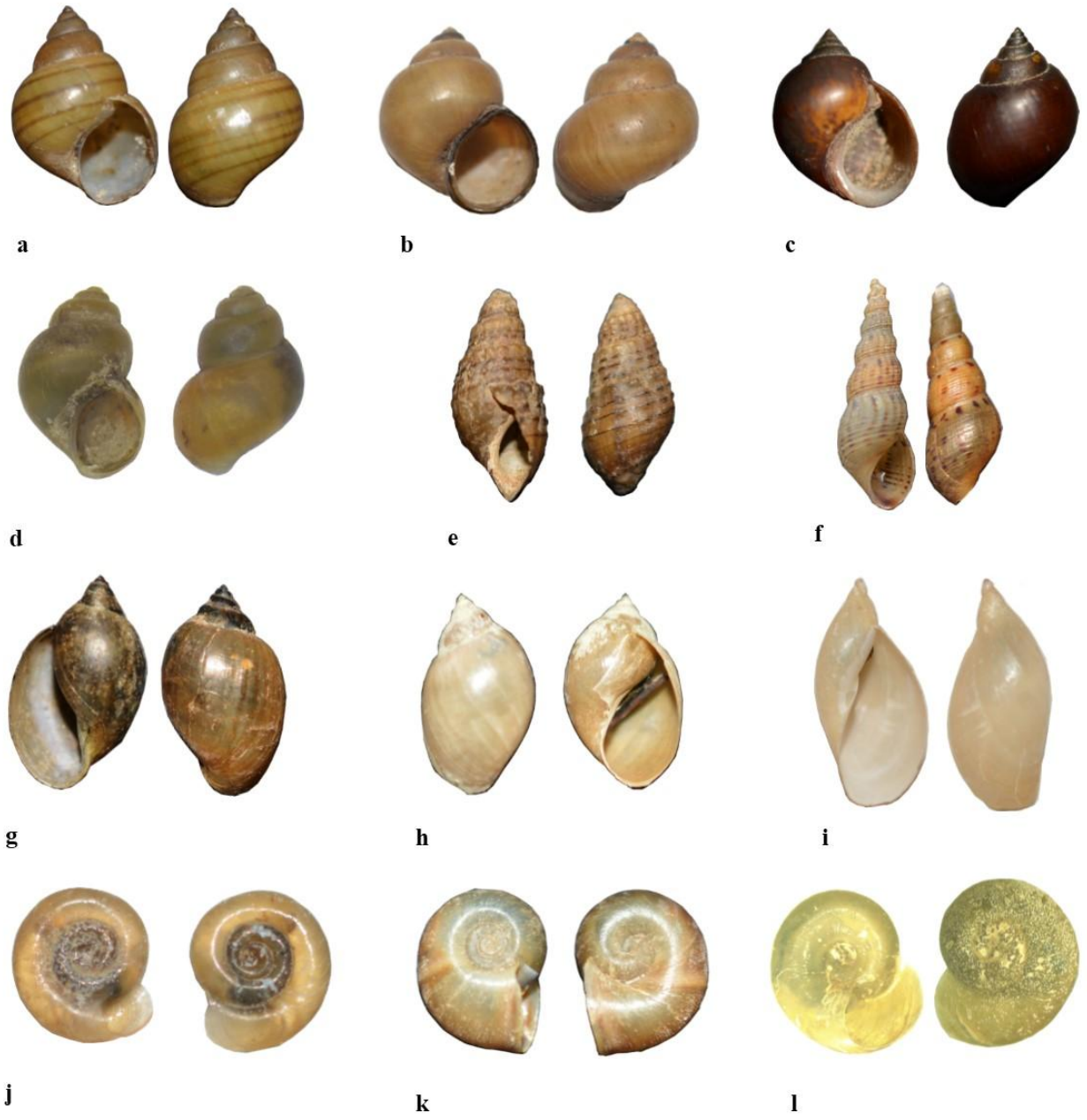
Mollusca comprises 85,000 extant and 35,000 extinct fossil species globally (Zhang, 2013). Approximately 35,000 land snails and 8765 freshwater species are reported globally (Lydeard et al., 2004). They constitute 7% of the total fauna (Benkendorff, 2010). 5070 extant mollusc species are reported from India. Of these, 1345 species are non-marine, which forms 4% of global non-marine molluscs. A consolidated document of 41 species of freshwater and 23 species of terrestrial molluscs is reported from Telangana (Chandra et al., 2021). In the present study, 66 species are reported exclusively from the Amrabad and Kawal tiger reserves of Telangana. Altogether, 33 freshwater specimens were collected (Table 3; Figures 4, 5 & 8), constituting 26 species from Kawal Tiger Reserve and 18 species from Amrabad Tiger Reserve, and a total of 33 land snails were collected (Table 4; Figures 6, 7 & 9), comprising 14 species from Kawal Tiger Reserve and 26 species from Amrabad Tiger Reserve.

Table 3 List of Freshwater Molluscs

S.No.	Family	Species	Kawal Tiger Reserve	Amrabad Tiger Reserve
	Class Gastropoda	-	-	-
	Order Cycloneritida	-	-	-
1	Family Neritidae	*Neripteron violaceum* (Gmelin, 1791)	+	-
	Order rchaitaenioglossa			
2	Family Viviparidae	*Filopaludina bengalensis* (Lamarck, 1822)	+	+
3		*Idiopoma dissimilis* (Mueller, 1774)	+	+
4	Family Ampullaridae	*Pila virens* (Lamarck, 1822)	+	-
	Order: Littorinimorpha			
5	Family Bithyniidae	*Gabbia stenothyroides* (Dohrn,1857)	+	-
6		*Gabbia orcula* (Frauenfeld, 1862)	-	+
	Oder Littorinimorpha			
7	Family Thiaridae	*Meiniplotia scabra* (Muller,1774)	+	+
8		*Melanoides tuberculata* (Mueller,1774)	+	+
9		*Tarebia granifera* (Lamarck,1816)	+	+
10	Family: Pachychilidae	*Paludomus rotunda* (Blanford,1870)	-	+
11		*Paludomus ornatus* Benson,1860	-	+
12		*Paludomus cf. annandalei* Preston, 1909	-	+
	Order Hygrophila			
13	Family Lymnaeidae	*Ampullaceana lagotis* (Schrank, 1803)	+	-
14		*Radix rufescens* (Gray, 1822)	+	+
15		*Racesina luteola* (Lamarck, 1822)	+	+
16		*Stagnicola tungabhadraensis* Ray,1967	+	-
17	Family Physidae	*Physella acuta* (Draparnaud,1805)	+	+
		Family Planorbidae		
18		*Gyraulus parvus* (Say, 1817)	+	-
19		*Gyraulus convexiusculus* (Hutton, 1849)	+	+
20		*Helicorbis cantori* (Benson, 1850)	-	+
21	Bulinidae	*Indoplanorbis exustus* (Deshayes,1834)	+	+

	Class: Bivalvia	-	-	-
	Order Arcida	-	-	-
22	Family Arcidae	*Scaphula nagarjunai* JanakiRam & Radhakrishna,1984	-	+
	Order: Uninoida	-	-	-
23	Family: Unionidae	*Lamellidens generosus (A. Gould, 1847)*	+	-
24		*Lamellidens corrianus* (Lea,1834)	+	-
25		*Lamellidens cf. jenkinsianus* (Benson,1862)	+	-
26		*Lamellidens marginalis* (Lamarck,1819)	+	-
27		*Parreysia corrugata* (Muller,1774)	+	-
28		*Indonaia bonneaudii* (Eydoux,1838)	+	-
29		*Indonaia caerulea* (Lea,1831)	+	-
30		*Indonaia cf. rugosa (Gmelin, 1791)*	+	-
31		*Indonaia gratiosa (Philippi, 1843)*	+	-
	Venerida	-	-	-
	Family Cyrenidae	-	-	-
32		*Corbicula striatella* Deshayes,1855	+	+
	Sphaeriida			
33	Sphaeriidae	*Hindupisidium clarkeanum (G. Nevill & H. Nevill, 1871)*	-	+

(+ = present; - = absent)



a. *Filopaludina bengalensis* (Lamarck, 1822) ; b. *Idiopoma dissimilis* (Mueller, 1774) ; c. *Paludomus ornatus* Benson,1860 ; d. *Gabbia stenothyroides* (Dohrn,1857) ; e. *Tarebia granifera* (Lamarck,1816); f. *Melanoides tuberculata* (Mueller,1774); g. *Physella acuta* (Draparnaud,1805); h. *Racesina luteola* (Lamarck, 1822); i. *Radix rufescens* (Gray, 1822); j. *Gyraulus parvus* (Say, 1817); k. *Indoplanorbis exustus* (Deshayes,1834) ; l. *Helicorbis cantori* (Benson, 1850)

Figure 4 Freshwater gastropods

a. *Parreysia corrugata* (Muller,1774); b. *Lamellidens corrianus* (Lea,1834); c. *Lamellidens marginalis* (Lamarck,1819); d. *Indonaia caerulea* (Lea,1831); e-*Corbicula striatella* Deshayes,1854; f. *Scaphula nagarjunai* JanakiRam & Radhakrishna,1984

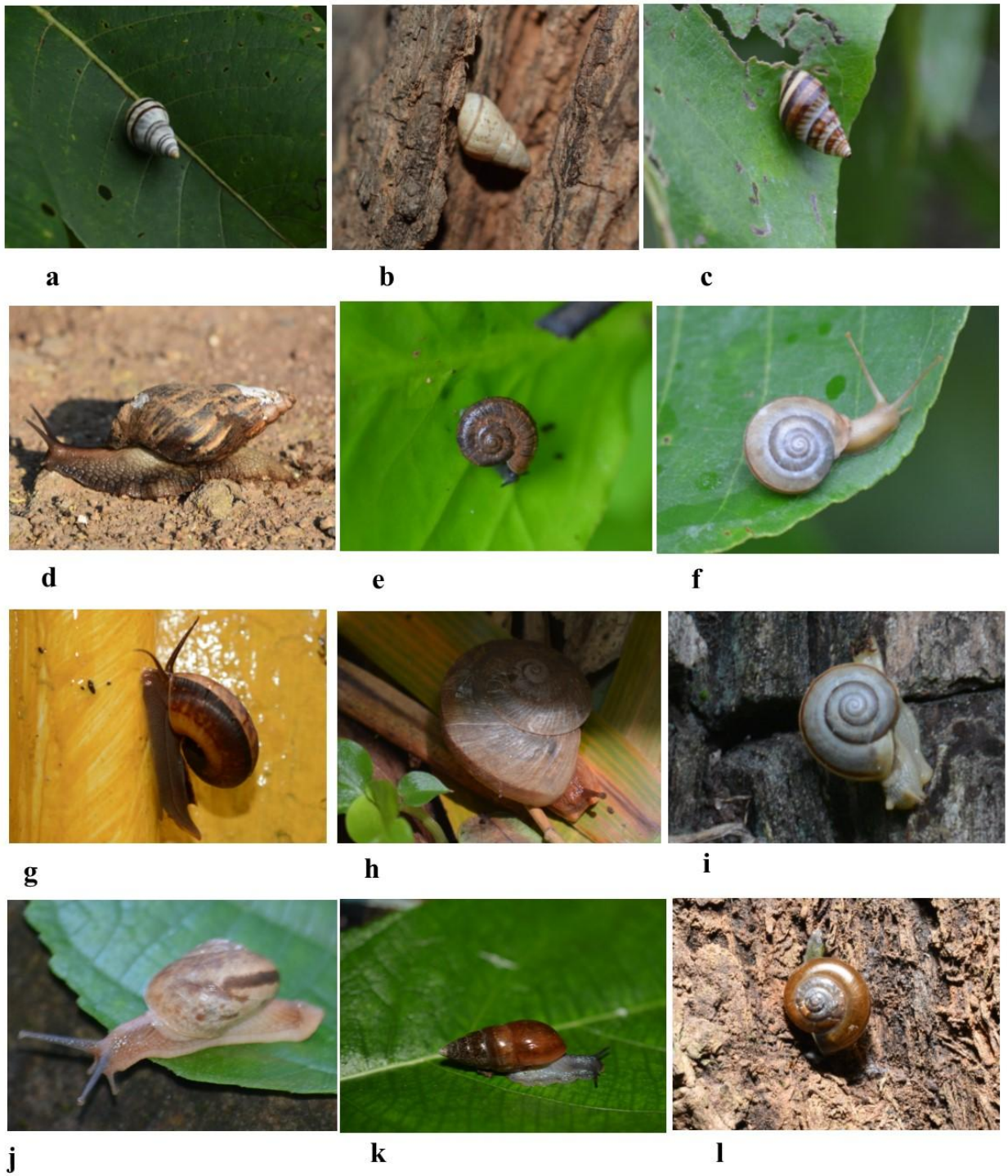
Figure 5 Freshwater bivalves

Table 4 List of Terrestrial Molluscs

S.No.		Species	Kawal	Amrabad
	Class Gastropoda	-	-	-
	Order Architaenioglossa	-	-	-
	Family Cyclophoridae	-	-	-
1		*Lagocheilus polynema* (Pfeiffer, 1854)	-	+
2		*Pterocyclus rupestris* (Benson,1832)	-	+
	Order Littorinimorpha	-	-	-
	Family Pomatiidae	-	-	-
3		*Cyclotopsis subdiscoidea* (G. B. Sowerby I, 1850)	-	+
	Order Stylommatophora	-	-	-

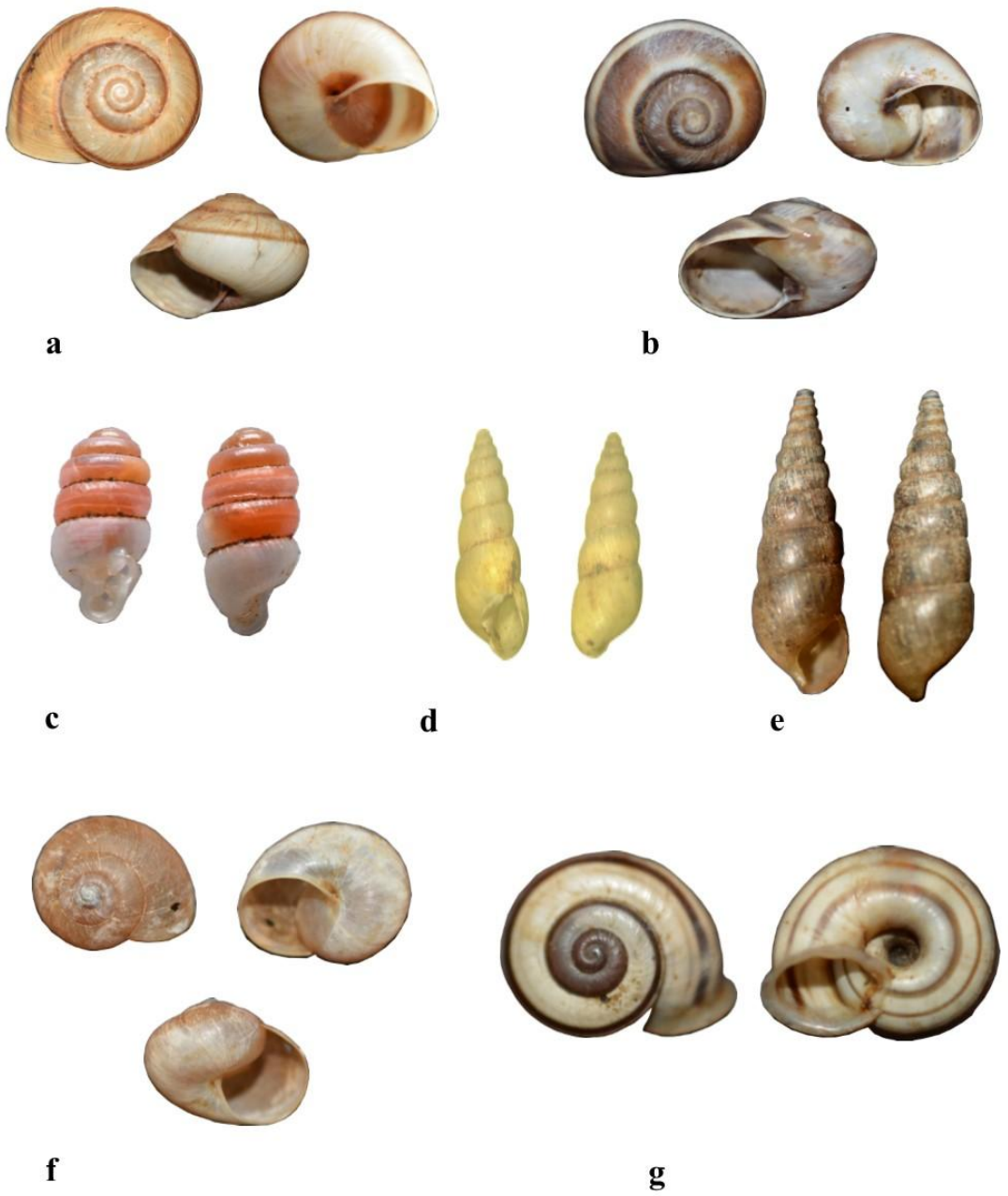
4	Family: Cerastuidae	*Rhachistia bengalensis* (Lamarck, 1822)	-	+
5		*Rhachistia cf. pulchra* (Gray, 1825)	-	+
6		*Rachis punctata* (Anton, 1838)	+	-
7	Family Achatinidae	*Lissachatina fulica* (Bowdich, 1822)	-	+
8		*Glessula brevis* (L. Pfeiffer, 1862)	-	+
9		*Glessula crassula* (Reeve, 1850)	-	+
10		*Glessula cf. hebes* (L. Pfeiffer, 1868)	-	+
11		*Glessula filosa* W. T. Blanford, 1870	+	+
12		*Glessula subfilosa* Beddome, 1906	-	+
13		*Glessula subtornensis* Gude, 1914	-	+
14		*Glessula cf. vadalica* (Benson, 1865)	-	+
15		*Rishetia tenuispira* (Benson, 1836)	-	+
16		*Subulina octona* (Bruguière, 1789)	+	-
17		*Allopeas gracile* (T. Hutton, 1834)	+	-
18	Family Streptaxidae	*Gulella bicolor* (T. Hutton, 1834)	+	-
19	Family Succineidae	*Quickia gravelyi* (Rao, 1924)	+	-
20	Family Chronidae	*Kaliella barrakporensis* (L. Pfeiffer, 1853)	+	+
21	Family: Ariophantidae	*Ariophanta himalana* (I. Lea, 1834)	-	+
22		*Ariophanta laidlayana* (Benson, 1856)	-	+
23		*Ariophanta cf. kadapaensis* (G. Nevill, 1878)	-	+
24		*Ariophanta belangeri* (Deshayes, 1832)	+	+
25		*Ariophanta maderaspatana* (Gray, 1834)	-	+
26		*Ariophanta albata* (W. T. Blanford, 1880)	-	+
27		*Ariophanta semirugata* (Beck, 1837)	+	+
28		*Euplecta travancorica* (Benson, 1865)	-	+
29		*Euplecta indica* (L. Pfeiffer, 1846)	+	+
30		*Macrochlamys perplana* Godwin-Austen, 1883	+	+
31		*Macrochlamys indica* Godwin-Austen, 1883	+	+
32	Family Camaenidae	*Trachia asperella* (L. Pfeiffer, 1846)	+	-
33		*Trachia fallaciosa* (Férussac, 1832)	+	-

(+ = present; - = absent)



a. *Rhachistia bengalensis* (Lamarck, 1822); b. *Rachis punctata* (Anton, 1838) ; c. *Rhachistia cf. pulchra* (Gray, 1825); d.*Lissachatina fulica* (Bowdich, 1822) ; e. *Pterocyclus rupestris* (Benson,1832); f. *Trachia fallaciosa* (Férussac, 1832); g.*Lagocheilus polynema* (Pfeiffer, 1854) ; h. *Ariophanta himalana* (I. Lea, 1834); i.*Trachia fallaciosa* (Férussac, 1832) ; j.*Ariophanta semirugata* (Beck, 1837); k. *Glessula subtornensis* Gude, 1914 ; l. *Macrochlamys indica* Godwin-Austen, 1883

Figure 6 Terrestrial gastropods-living snails



a. *Ariophanta laidlayana* (Benson, 1856); b. *Ariophanta cf. kadapaensis* (G. Nevill, 1878); c. *Gulella bicolor* (T. Hutton, 1834); d. *Allopeas gracile* (T. Hutton, 1834); e. *Rishetia tenuispira* (Benson, 1836); f. *Ariophanta belangeri* (Deshayes, 1832);

Figure 7 Terrestrial gastropods-shell

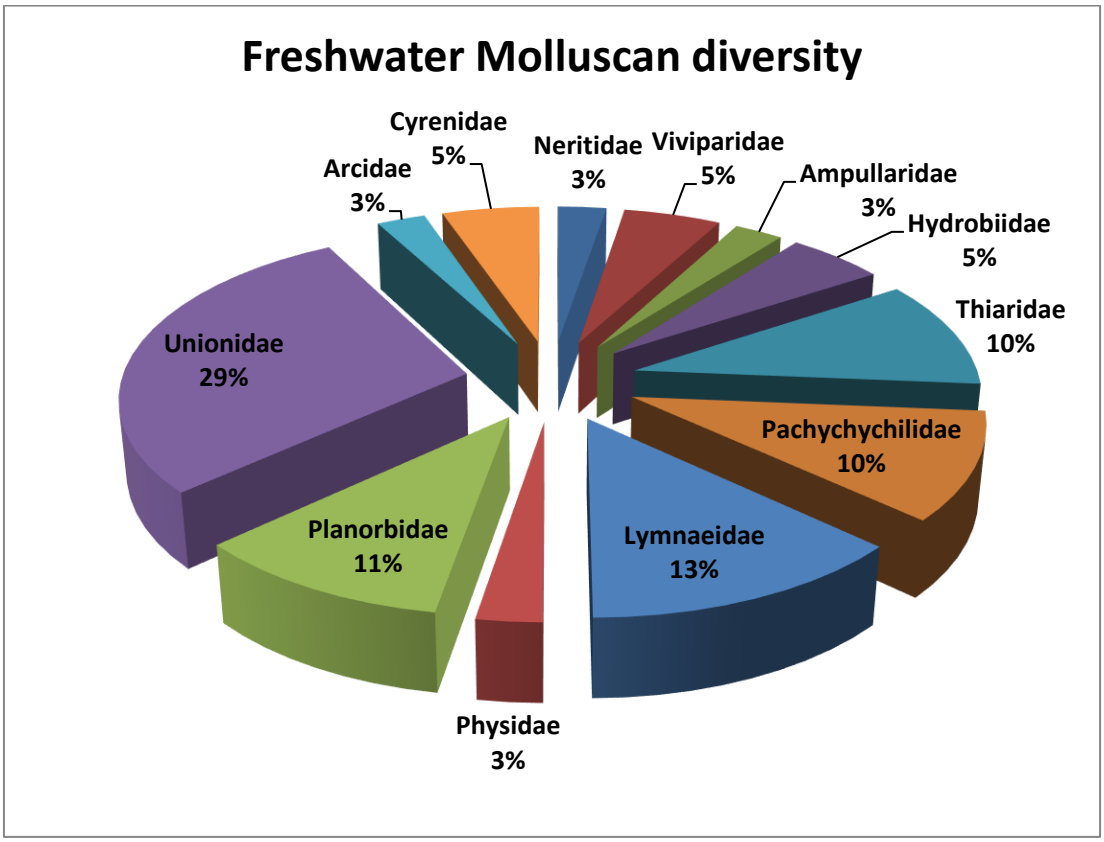


Figure 8 Diversity of Freshwater Molluscs

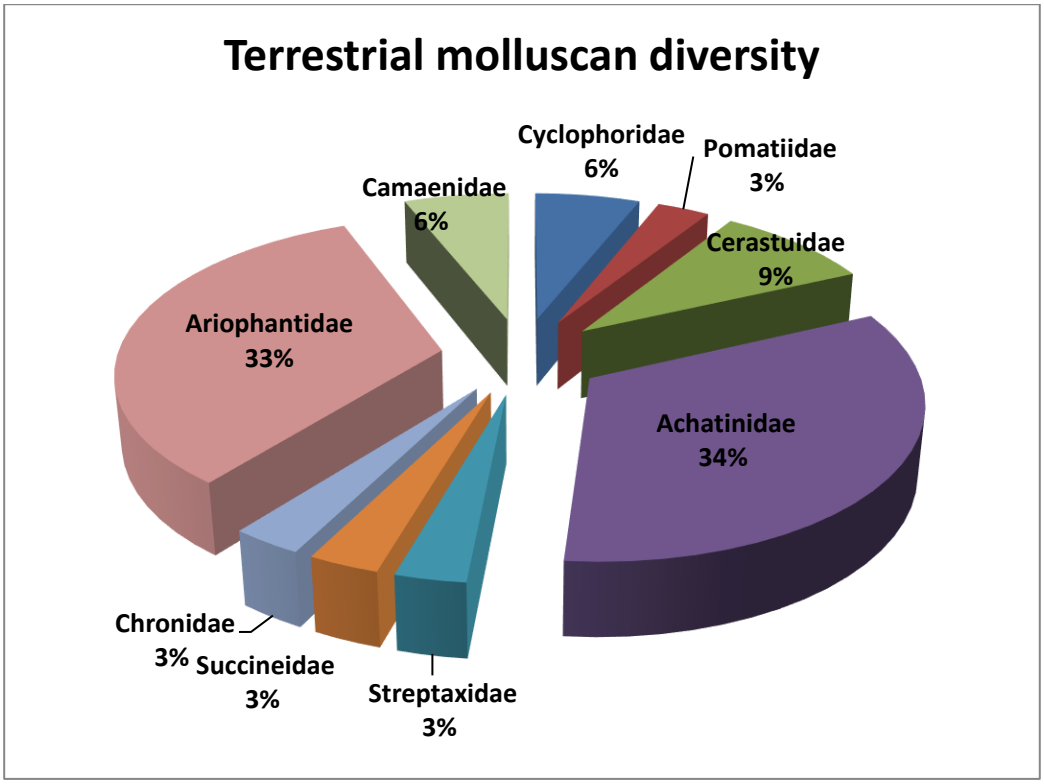


Figure 9 Diversity of Terrestrial Molluscs

4. DISCUSSION AND CONCLUSION

In the present study, a total of 66 species of non-marine molluscs belonging to 21 families were recorded over 3 years from two tiger reserves of Telangana. A total of 33 freshwater species accommodated under 12 families and, 33 land snails belonging to 9 families were recorded from two tiger reserves. Species variation was observed in both the tiger reserves. Freshwater species were highly diverse in terms of species richness in Kawal Tiger Reserve while Amrabad Tiger Reserve harbors a diverse population of terrestrial molluscs. This variation may be due to the presence of better water resources like Kadam Reservoir in the Kawal Tiger Reserve and better habitat ecology in Amrabad Tiger Reserve. Gastropoda was the dominant class in either of the reserves. *Filopaludina bengalensis and Radix rufescens* were the most ubiquitous freshwater species, while *Macrochalmys indica* and *Ariophanta sp*. were in terrestrial habitats.

The present work incorporates further 6 species of freshwater and 16 terrestrial to the malacofaunal inventory of Telangana. Some of the freshwater and terrestrial species documented from the Amrabad tiger reserve are comparable to those reported from Western Ghats e.g. *Paludomus annandalei*, etc. (Raheem et al., 2014). Some of the species still await taxonomic confirmation. Unionidae was found to be the most speciose family in freshwater with 9 species and Achatinidae and Ariophantidae in terrestrial habitats with 11 species each. Vulnerable and endemic species viz., *Scaphula nagarjunai*, as well as, invasive and alien species like *Lissachatina fulica, Physella acuta* were documented. This study recommends future malacological investigations, and ecological studies in the study region to effectively evaluate the diversity and to manage invasive, endemic, threatened molluscan fauna of these tiger reserves.

Acknowledgement

The authors are grateful to the authorities of Acharya Nagarjuna University, Andhra Pradesh, India, the Director, Zoological Survey of India, Kolkata for providing necessary facilities and the Officer-in-Charge, Freshwater Biology Regional Centre, Zoological Survey of India, Hyderabad for continual encouragement and guidance. Thanks, are also due to the Telangana State Forest Department for providing necessary permissions and support during the field studies.

Authors' Contributions

All authors have equal contributions in the manuscript

Ethical approval & declaration

In this article, as per the animal regulations followed in Department of Zoology, Acharya Nagarjuna University, Andhra Pradesh, India, the authors observed 66 species of non-marine molluscs, including 33 land species and 33 freshwater species. Identified species were labelled and deposited in the National Zoological Collection in Freshwater Biology Regional Centre, Zoological Survey of India, Hyderabad, Telangana, India. The Animal ethical guidelines are followed in the study for species observation, identification & experimentation.

Informed consent

Not applicable

Conflicts of interests:

The authors declare that there are no conflicts of interests.

Funding:

The study has not received any external funding.

Data and materials availability

All data associated with this study are present in the paper.

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