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Diversity of Millipedes in Chandoli National Park, Western Maharashtra, India

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Abstract
Millipedes diversity were analysed at Chandoli National Park of South Western Maharashtra. It lays at Longitude 73^0 40 and 73^0 53 E latitude 17^0 03 and 17^0 20 N in Sangli district of Western Maharashtra. Chandoli National Park lies between the Radhanagiri and Koyna Wildlife Sanctuaries and form the Southern part of the Sahyadri Tiger Reserve. Millipede abundance and more diversity was found at national park influence by lees disturbance of local habitat and availability of plenty food. In present study, millipede species, *Harpaphe haydeniana*, *Arthrosphaera magna*, *Arthrosphaera fumosa*, *Trigoniulus corallines*, *Oxidus gracilis*, and *Spinotarsus colosseus* are present. Abundance of millipede is due to moderate canopy and litter, which support undestroyed vegetation such as shrubs and herbs.

Keywords: Chandoli National Park, Diversity, Millipede, Western Maharashtra.

Introduction
Biodiversity is the variety of life on earth; it includes all organisms, species, and populations. Biodiversity offers several direct and indirect economic benefits to humankind (Ehrlich *et al*., 1992) [14]. There is positive relationship between diversity and ecosystem had been studied by several experiments (Purvis and Hector, 2000. Mc Cann, K.S., 2000). The biotic diversity contributes significantly to maintaining nutrients in the soil, maintaining water, converting waste materials into nutrients and climatic cycle. Soil macro fauna makes an important role to soil fertility by promoting the stability and productivity of forest ecosystem, mainly due to their influence on soil process such as litter decomposition and nutrient dynamics (Irmler, 2000) [8]. Diplopods are widespread on all continents except Antarctica (Hoffman *et al*., 2002) [17] [16]. Diplopoda (Millipedes) are a mega-diverse group of terrestrial Arthropoda after insects and Arachnida comprising globally an estimate of perhaps up to 80,000 species or subspecies, of which only about 12,000 have been described (Hoffman, 1980, 1982; Shelley, 2007; Brewer, Sierwald & Bond, 2012) [16, 11]. Among soil Arthropods, millipedes are remove plant debris and play a important role in soil formation process. Many millipedes can also serve as indicators of Environmental conditions and improve the structure content of organic matter and nutrient elements of soil (Loranger-Merciris *et al*.,2007; Seeber *et al*., 2008) [24]. Diversity of forest litter inhabiting ants along an elevation gradient in the Wayanad region of Western Ghats was studied by Sabu *et al*. (2008). Millipede are mostly found in their typical habitats (forest litter, rotting wood, plant debris and compost) as well as in the high mountain, in caves or in the soil, only occasionally to marginally occurring also on the marine littoral, in freshwater habitats, in the desert, in tree canopies or few other environments regarded as extreme for this arthropod group (Golovatch & Kime, 2009) [15]. Koli *et al*. (2010) was studied Orthopteran fauna in various natural and anthropogenic habitats of Chandoli National park. Ambarish and Sridhar (2013) [8] was studied the distribution, ecology, and bioconversion, systematics conservation of rare and endemic pill-millipedes of the Western Ghats. Cytological and karyological observation of two endemic giant pill-millipedes were studied by Cheviri *et al*. (2014). Stridulation and courtship behaviour of four endemic pill-millipedes of Western Ghats were studied by Cheviri *et al*. (2016). The study of Diversity of millipede in Yelagiri hills, Eastern Ghats, Vellore district, Tamil Nadu were carried by Chezhian and Prabakaran (2016) [13]. Diversity and distribution of millipedes in the Campo Ma'an National park of Southern Cameroon were studied by Paul Serge Mbenoun Masse *et al*. (2017). Diversity of millipedes at in around the Northern and Western Ghats of Rajgurunagar,

India was studied by Patil *et al*. (2018). Pardeshi (2019) [25] was studied morphological, ecological, and behavioural study of millipedes in the field of Bambrood district Jalgaon, Maharashtra. In Chandoli National-park of Western Ghats, India no one studied on the diversity, and the role of millipedes in forest ecosystems, therefore, the broad objective of the present study is carried out.

Materials and Methods

Study area

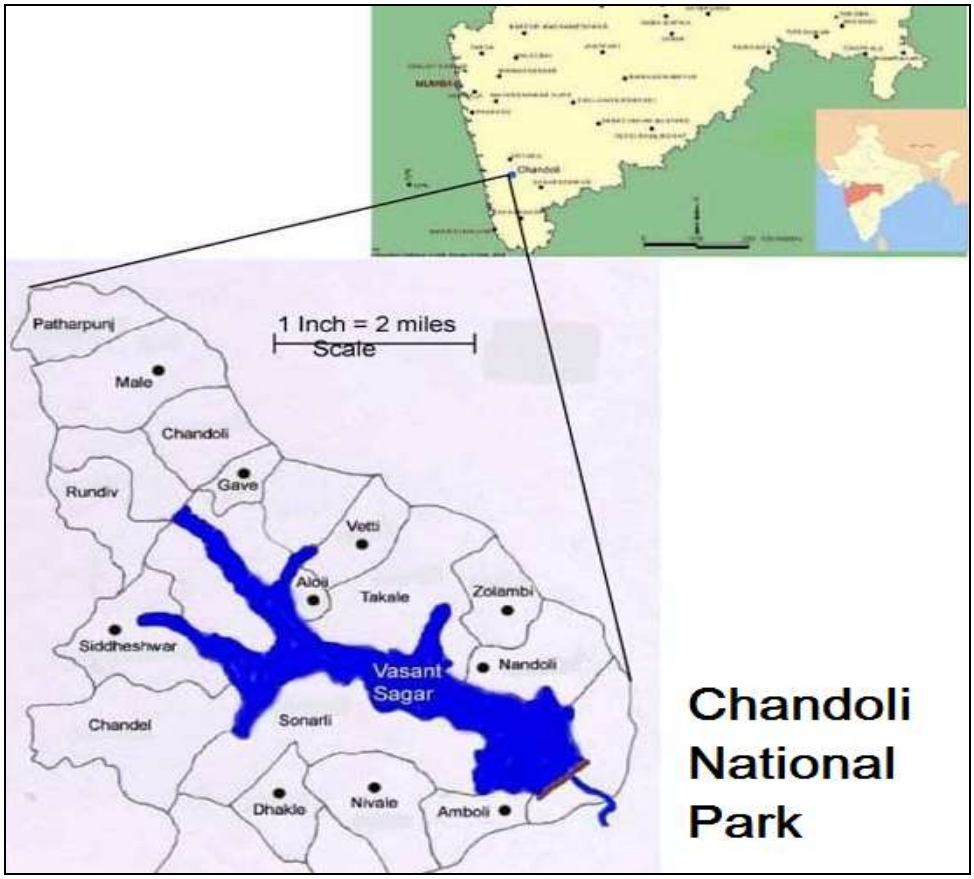

Fig 1: Map of Study area

The newly formed habitat of Chandoli National Park (Fig. 1) is at the junction area of four districts (Sangli, Kolhapur, Satara and Ratnagiri). It lays at Longitude 73^0 40 and 73^0 53 E latitude 17^0 03 and 17^0 20 N in Sangli district of Western Maharashtra. It **is** located between the Radhanagiri and Koyna Wildlife Sanctuaries and form the Southern part of the Sahyadri Tiger Reserve. A very distinct feature is the presence of numerous barren rocky lateritic plateaus locally called 'Sadas' devoid of any perennial vegetation and numerous fallen boulders with dense thorny secondary vegetation. The area is about 308.97 Km2. The maximum temperatures during day time ranges from 30 °C to 38 °C. From October both day and night temperatures decrease progressively. In December or January the temperature often is up to 26 °C in day time. During rainy season maximum and minimum temperature is remains between 11-28 °C. The all area is characterized by humid and mild climate; there are heavy rains during the South West monsoon season, from June to September. Pre monsoon starts in April. Therefore, this area has no notable dry season. The cold season is from December to February, followed by the pleasant summer season from March to May. The forest types are tropical hill forest, semi- evergreen forest and mixed deciduous forest. Five locations were selected by considering available conditions, which were visited every month from June 2018 to April 2019. Observation of millipedes was made through different quadrats. Millipedes were collected from study sites by hand picking and species were identified by using various field guides and available lecture.

Results and Discussion

The species were observed as follows 1. *Harphaphe haydeniana*: (Cook 1904) belongs to order Polydesmida and family Xystyodesmidae. It is yellow spotted millipede and reaches a length of 4-6cm, width of 0.1 to 0.3cm and weight of 0.9 to 2.0g. The body is black and is distinctively marked along the sides with patches of a yellowish colour. It consist 10-20 body segments. It is found in moist places in study area. This species is observed in month December and January. This species consume more percentage leaf litter above ground (Carcamo *et al*., 2000) [12]. Fragmentation of leaf litter by mandibles are increased more surface area of leaf litter (Kheirallah, 1990). 2. *Arthrosphaera magna*: (Attems, 1936) [1] belong to order Sphaerotheriida and family Sphaerotheriidae. Fully mature species have 13 body segments. The juveniles are generally olive green colour. The head of mature species is yellow brown or olive brown or olive green. The average weight of 4.5 to 12.6g, length 3.5 to 7.0cm and width of 1.2 to 2.5cm. Predominately found in study area. This species is roll-up into a complete ball varies

from a marble up to a baseball showing island gigantism (Wesener *et al*., 2010) [27]. Recently some studies have been carried out on the occurrence, distribution, diurnal periodicity, morphology, cytology, influence of soil edaphic, leaf litter preference, organic matter processing and gut bacteria of *Arthrosphaera* magna is widely dispersed in the foothills of Maharashtra, Karnataka and Tamil Nadu (Attems, 1936; Sakwa, 1974; Achar, 1980; Ashwini and Sridhar, 2008) [1, 2, 7]. *Arthrosphaera* of Western Ghats (Ashwini and Sridhar, 2005, 2006a, 2006b, 2006c; Kadamannaya and Sridhar, 2009a, 2009b; Kadamannaya *et al.*, 2010a, 2010b; Kampfer *et al*., 2011) [3, 4, 5, 6, 19, 20, 21, 22, 23]. 3. *Arthrosphaera fumosa* (Pocock, 1895) belong to order Sphaerotheriida and family Sphaerotheriidae. Bothe species such as *A. magna* and *A. fumosa* constant tilling of soli particles and stay in constructed burrow (Ambarish and Sridhar, 2015) [9]. 4. *Trigoniulus corallines* (Gervais, 1847) belong to order Spirobolida and family Trigoniulidae. Rusty millipedes are common in this area. Brick red colour present in group on open land in rainy season due to patchy distribution of food, soil moisture and sexual attraction. 5. *Oxidus gracilis* (C. L. Koch, 1847) belong to order Polydesmida and family Paradoxosomatidae. Garden millipede, common in summer, length 5 cm and with 16 segments. The latter is dark brown colour with yellow strips. The most widely distributed millipede in the world called yake-yasude in Japan. The native range of the species is East or Southeast Asia (STOEV and KORSOS, 2010) [26]. This species emit a nasty smell when touched, previous study mentioned that due to presence of benzaldehyde and hydrogen cyanide are defensive substances (Towers *et al*., 1972). 6. *Spinotarsus colosseus* (Attems, 1928) belong to order Spirostreptida and family Odontopygidae. Dark black colour. The length is 7 to 14 cm and body segments are 55 to 60.

The population density of millipede was higher in study area during rainy season similar finding revealed that soil fauna population in many temperature region are generally higher during spring and rainfall (Levings and Windsor, 1985 and Borlow, 1957) [10]. Further Wallwork (1976) and Lokain, (1966) recorded definite pattern of population fluctuation with peak during rainy season followed by winter and hot and dry summer month.

Fig 1: *Harphaphe haydeniana*

Fig 2: *Xenobolus carnifex*

Fig 3: *Oxidus gracilis*

Fig 4: *Arthrosphaera magna*

Fig 5: *Arthrosphaera fumosa*

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