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ECOLOGICAL ADAPTATION AND PHOROPHYTIC RELATIONSHIP OF ORCHID FLORA IN SIMILIPAL BIOSPHERE RESERVE, ODISHA, INDIA: AN ECOLOGICAL STUDY TO CONSERVE ORCHIDS

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Abstract

During the present study, the distribution and phytosociological association of orchids with higher plants were determined. All the orchid species were noted down from each site with the association of the phorophytic plants. Altogether, 43 orchid species along with 52 tree species were recorded from all the six studied sites. The more number of species were presently observed in the Gurguria region followed by Chahala. Amongst these phorophytic plants, only 9 tree species were mostly associated with epiphytic orchids which gave shelter and shade to these plants. The girth class relations to the orchid species were monitored at each site; these revealed that GBH [Girth at Breast Height (61 cm - 150 cm)] were always preferable for orchids, because the dead cell mass and the dust particles along with some gum secreted by the phorophyte was always deposited on that and this might be the reason for growth of moss and epiphytic orchids on that girth class. The most favourable locality of the ground orchids was sandy soil along with high humidity. Furthermore, fragmentation of habitats, removal of key species critical to the continued existence of ecosystems, increased susceptibility to fire threats, pollinator decline, and introduction of feral animals were also documented to result in drastic losses in orchid populations and diversity. However, detailed information on orchid population and biology is needed to assist conservationists so as to develop an appropriate management strategies in highly fragmented and altered landscapes. Presently, the main approach was to find out the ecological stress related to girth class preference of phorophytes on orchid flora of Similipal Biosphere Reserve and their subsequent management, in future.

Introduction

ORCHIDS BELONG to the second largest family of flowering plants, Orchidaceae; these are distributed from tropical to alpine areas of the world. These plants are mostly found in the form of epiphytes, lithophytes or terrestrials. For growth of epiphytes, a suitable host plant (phorophyte) is always required, whereas lithophytes require suitable rock surface or stony soils. The terrestrial species grow on sandy or clayey soils which provide them the nutrients. In case of epiphytes, the host plant is important not only for nutritional requirement, but also for its attachment, germination, and for sustainability. There is a velamen tissue in the roots of the epiphytes which aids in the absorption and storage of atmospheric moisture.

In nature, the host specificity of epiphytic orchids varies from species to species. Generally, these prefer tree species, which have thick and rough barks for their attachment. Not only this, but these plants also prefer different girth class of the phorophytes as a substrate for their attachment. Annasevalam and Parthasarthy (2001) studied the distribution of epiphytic orchids in evergreen forests of Varagaliar, Western Ghats with respect to the girth class of phorophytes. Jalal (2005) studied the bark of host species for epiphytic orchids along with altitudinal gradient and found that phorophytic species with cracked barks are mostly favoured by epiphytic orchids. He also reported that areas above the height of 1500m amsl, where only trees with smooth bark grow in Himalayan region lack epiphytic orchids. Vij *et al.* (1983) also stated that the rough bark trees are generally the treasure-house of epiphytic orchids. Moreover, the dynamics of the substratum (at the level of bark, twigs, branches, entire host tree) may strongly influence the population dynamics of epiphytes (Zotz and Hietz, 2001).

Similipal, the only Biosphere Reserve of the Odisha, India, is the treasure house of both epiphytic and ground orchids due to its favourable climatic conditions for their growth and development. Now these plants are facing different degrees of threats for their survival due to habitat loss, fragmentation of forest covers, and anthropogenic pressures. Like other biosphere reserves, national parks, wildlife sanctuaries and protected areas in India, the study on ecology of orchids with respect to phorophytic specificity and other related aspects is limited. Keeping these in view, the present study was conducted so as to prepare a preliminary database on distribution of epiphytic orchids with respect to girth class of phorophytes and for this purpose, a total of six sites (five sites around SBR and one in central core part) were taken as the study sites (Fig. 1). The study also aimed at providing information on conservation of epiphytic orchids, in their natural habitats.

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Material and Methods

Phytosociological Study

Intensive field surveys were conducted during 2007-2010 in six different sites of Similipal Biosphere Reserve (SBR), Odisha (N 21° 34' to 22° 05', E 86° 04' to 86° 34') covering all the seasons of the year. The study sites were differing from each other with respect to tree species composition and structural heterogeneity. Stratified random sampling was done in each study site following Misra (1968) and Muller-Dombois and Ellenberg (1974). Ten quadrats [20 m × 20 m (400m^2)] were laid down in each study site for ascertaining phytosociological parameters of phorophytes. In each quadrat, five 1 m × 1 m quadrats were laid down randomly to ascertain the ground orchid species. The orchid species were identified with the help of Flora of Orissa (Saxena and Braham, 1995) and Orchids of Orissa (Misra, 2004). The voucher specimens were deposited in the herbarium and live plants were grown in the shade net house of the Department of Botany, North Orissa University, Takatpur, Baripada.

Quantitative Analysis

Analytical features such as frequency, density, and dominance of orchid species and phorophytes were calculated following Dash (2001). Distribution pattern was analyzed on the basis of abundance (Kershaw, 1973)

Important Value Index (IVI)

Here, the forest types amongst the sampling area were characterized by calculation IVI index of phorophyte species (Kumar, 2007). The ecological status of a species with respect to a community structure can be obtained only by synthesizing the percentage values of frequency, density, and basal area in terms of relative frequency, relative density, and relative basal area. The values when added together obtain the IVI of each species (Dash, 2001)

IVI= Relative Frequency + Relative Density + Relative Dominance

Relative Frequency= (Frequency of a species/Total frequency of all species) × 100

Relative Density= (Individuals of a species/Individuals of all species) × 100

Relative Dominance= (Basal area of a species/Basal area of all species) × 100

Measurement of α, β and γ- Diversity

The diversity of species within an ecological community, more particularly, the species richness of standard sample sites, where richness was the number of species in the community, was calculated by α-diversity (Das, 2001). The diversity of species amongst communities was calculated by β-diversity (Whittaker, 1972). The diversity of species across study site with reference to ecological adaptation was calculated by γ-diversity (Vane-Wright *et al.,* 1991).

Girth Class Preference of Orchid Species

Orchid association with phorophyte was characterized by taking to the girth class classification of phorophyte (Saxena and Singh, 1984). On basis of GBH, the plants were classified into following class (Kumar, 2007).

Table 1. Girth class classification of phorophyte plants.

Class	Range of GBH (in cm)
T_1	30.1-60
T_2	60.1-90
T_3	90.1-120
T_4	120.1-150
T_5	>150

Community Ordination

The orchid species' populations along with the phorophytes girth class were summarized and the relations amongst six different sites of SBR were determined by Principal Components Analysis (PCA). The number of phorophytes was calculated to the hector (Plants/hector). The population size in each site (Plants/ hector relation to the orchid numbers) were transferred

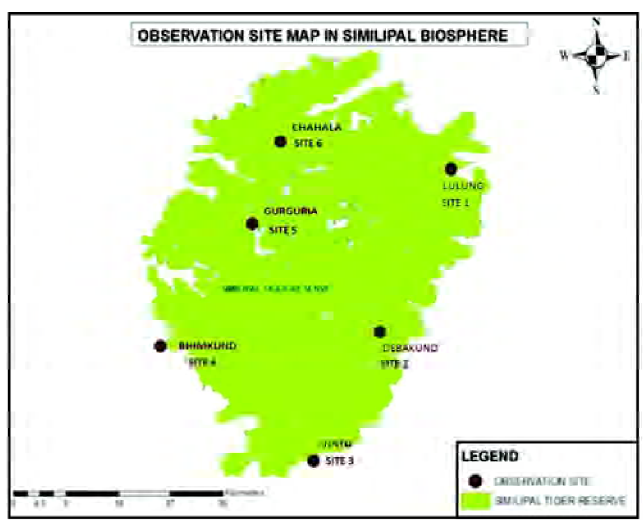

Fig. 1. Map showing all six sites of observations in Similipal Biosphere Reserve.

Table 2. Species composition of orchids in six different study sites of Similipal Biosphere Reserve (SBR).

Orchid species	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6
Acampe ochracea (Lindl.) Hochr.	—	—		—	++	++
A. praemorsa (Roxb.) Blatt. & McCann	+++	+++	+++	+	+++	+++
A. rigida (Buch.-Ham ex J.E.Sm.) P.F.Hunt.	—	—	+++	++	—	++
A. carinata (Griff.) Panigr.	++	—	++	—	++	—
Aerides multiflora Roxb.	—	+++	—	—	+++	+++
A. odorata Lour.	+++	+++	++	—	+	+++
Bulbophyllum crassipes Hook.	++	+++	+	—	+	++
B. macraei (Lindl.) H.G. Rchb.	—	—	+	—	—	—
Cymbidium aloifolium (L.) Sw.	+++	+++	—	—	+++	+
Dendrobium crepidatum Lindl.	—	—	—	—	—	—
D. formosum Roxb.	—	—	—	—	++	++
D. herbaceum Lindl.	—	—	—	—	—	++
D. moschatum (Buch.-Ham.) Sw.	++	++	—	—	+	—
D. macrostachyum Lindl.	—	—	—	—	—	—
D. transparens Wall.	—	++	—	—	++	—
D. aphyllum (Roxb.) C.E.C.Fisch	++	++	—	—	+++	+++
D. regium Prain J.	—	—	—	—	—	+
Gastrochilus inconspicuum (Hook.f.) Kuntze	—	—	+	—	++	—
Geodorum densiflorum (Lam.) Schltr.	—	—	—	++	—	—
G. recurvum (Roxb.) Alston	—	—	—	++	—	—
Habenaria furcifera Lindl.	—	+	—	++++	+	—
H. roxburghii (Pers.) R.Br. Prod.	—	—	—	++++	—	—
H. plantaginea Lindl.	—	—	—	++++	—	—
H. commelinifolia (Roxb.) Wall. ex Lindl.	—	—	—	++++	—	—
Luisia trichorhiza (Hook.) Blume	++	—	—	—	++++	++
Micropera pallida (Roxb.) Lindl.	—	—	++	—	++	++
Nervilia aragoana Gaudich.	++	++	+++	++++	—	—
N. infundibulifolia Blatt.	—	+	—	+	+++	—
N. plicata (Andr.) Schltr.	—	++	++	+++	—	+
N. prainiana (King & Pantel) Seidenf.	—	—	++	++	—	—
Oberonia falconeri Hook.	++	+++	—	—	—	—
O. proudlockii King and Pantlling	—	—	—	—	—	++++
O. ensiformis (J.E.Sm.) Lindl.	—	—	—	+++	++++	++++
Pelatantheria insectifera (Rchb.f.) Ridl.	++	—	++	—	+	—
Peristylus constrictus (Lindl.) Lindl.	—	—	—	++	—	—
Pholidota imbricata Lindl.	—	—	++	—	+	++++
P. pallida Lindl.	++	++	—	—	—	++
Rhynchostylis retusa (L.) Blume	++	++	—	—	++++	++++
Smitinandia micrantha (Lindl.) Holtt.	—	++	—	—	++	+
Staurochilus ramosus (Lindl.) Seidenf.	—	+++	—	—	—	+
Tainia hookeriana King and Pantling	—	—	—	—	+	—
Vanda tessellata (Roxb.) Hook.	+++	++++	++++	++++	++++	++++
V. testacea (Lindl.) Rchb.	++	—	—	++	++++	++

+, present in one to two quadrates; ++, present in three to four; +++, present in five to six; ++++, present in seven to eight; +++++, present in nine to ten quadrates.

Table 3. IVI value of plant species at six different sites of SBR.

Species	IVI value at					
	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6
Aegle marmelous (L.) Corr.	0.00	0.00	3.78	0.00	0.00	0.00
Alangium salvifolium (L.f.) Wang	0.00	12.19	0.00	0.00	0.00	0.00
Albizia procera (Roxb.) Benth.	7.92	2.66	4.19	0.00	0.00	0.00
Alstonia scholaris (L.) R.Br.	0.00	0.00	0.00	0.00	4.14	0.00
Anogeissus latifolia (Roxb. ex Dc.) Wall. ex Guill. & Perr.	16.79	11.73	8.02	17.24	24.82	16.00
Ardisia solanacea Roxb.	0.00	0.00	0.00	0.00	4.29	0.00
Bombax ceiba L.	0.00	0.00	9.19	0.00	0.00	0.00
Bridelia retusa (L.) Spreng.	18.12	9.14	0.00	0.00	8.64	5.57
***Buchanania lanzan* Spreng.**	**0.00**	**0.00**	**3.88**	**18.71**	**6.94**	**0.00**
Butea monosperma (Lam.) Taub.	0.00	0.00	6.31	0.00	9.89	0.00
B. superba Roxb.	0.00	4.34	0.00	0.00	0.00	0.00
Canthium dicoccum (Gaertn.) Teijsm & Binnend	0.00	0.00	0.00	0.00	0.00	10.05
Careya arborea Roxb.	17.75	12.46	13.08	0.00	0.00	10.75
Casearia graveolens Dalz.	13.70	0.00	0.00	0.00	0.00	0.00
Cassia fistula L.	0.00	6.03	0.00	0.00	0.00	0.00
Cleistanthus collinus (Roxb.) Benth. ex Hook.f.	7.69	0.00	0.00	0.00	0.00	0.00
Croton roxburghi Balak.	18.76	15.16	18.93	10.97	6.86	11.66
Dalbergia sissoo Roxb.	0.00	2.20	1.95	0.00	0.00	0.00
Dillenia aurea Sm.	0.00	0.00	0.00	5.18	0.00	0.00
D. pentagyna Roxb.	0.00	6.33	0.00	0.00	0.00	0.00
***Diospyros malabarica* (Desr.) Kostel.**	**0.00**	**0.00**	**0.00**	**21.51**	**10.12**	**5.89**
D. montana Roxb.	9.48	0.00	0.00	14.92	9.08	0.00
D. melanoxylon Roxb.	0.00	7.02	6.83	10.74	0.00	0.00
D. sylvatica Roxb.	11.31	8.95	0.00	14.89	0.00	0.00
Grewia tilifolia Vahl.	6.48	0.00	0.00	0.00	0.00	0.00
Haldinia cordifolia (Roxb.) Ridsd.	0.00	10.29	6.97	0.00	0.00	10.92
Holarrhena pubescens (Buch.-Ham.) Wall ex G.Don	0.00	0.00	0.00	0.00	6.16	0.00
Ixora pavetta Andr.	0.00	0.00	1.94	0.00	0.00	0.00
Leea asiatica (L.) Ridsdale	0.00	2.06	0.00	0.00	0.00	0.00
***Madhuca indica* Gmel.**	**4.77**	**12.52**	**30.90**	**0.00**	**9.64**	**0.00**
***Mangifera indica* L.**	**15.15**	**25.15**	**23.04**	**0.00**	**10.01**	**0.00**
Mitragyna parvifolia (Roxb.) Korth.	0.00	8.44	0.00	0.00	0.00	5.48
Murraya paniculata (L.) Jack	0.00	0.00	3.96	0.00	0.00	0.00
Nyctanthes arbor-tristis L.	0.00	0.00	0.00	0.00	5.27	12.20
Ochna obtusata Dc.	0.00	0.00	5.99			
Phyllanthus emblica L.	10.47	9.01	0.00	7.48		8.96
Pongamia pinnnata (L.) Pierre	0.00	0.00	0.00	0.00	0.00	1.83
Protium serratum (Wall. ex Colebr.) Engl.	26.89	10.39	15.23	10.54	15.61	10.55
Pterocarpus marsupium Roxb.		6.54	0.00	11.19	9.84	0.00
P. acerifolium (L.) Willd.	0.00	0.00	4.92	0.00	0.00	0.00
***Schleichera oleosa* (Lour.) Oken**	**0.00**	**8.18**	**11.32**	**0.00**	**0.00**	**13.72**
Saraca asoca (Roxb.) W.J.de Wilde	0.00	5.96	0.00	0.00	0.00	0.00
***Shorea robusta* Gaertn. F.**	**81.59**	**57.64**	**77.29**	**88.76**	**119.77**	**98.79**
Stereospermum chelonoides (L.F.) Dc.	0.00	0.00	0.00	0.00	0.00	3.70

Table 3. IVI value of plant species at six different sites of SBR. (contd.)

Species	IVI value at					
S. xylocarpum (Roxb.) Benth.	0.00	0.00	0.00	0.00	0.00	3.75
Symplocos racemosa Roxb.	0.00	0.00	0.00	8.31	0.00	0.00
Syzygium cumini (L.) Skeels	7.60	15.15	17.19	20.01	16.02	3.92
S. operculata	0.00	0.00	0.00	0.00	0.00	2.94
***Terminalia alata* Heyne ex Roth**	**18.28**	**17.27**	**20.62**	**20.76**	**17.74**	**45.56**
***T. bellirica* (Gaertn.) Roxb.**	**7.28**	**13.21**	**4.46**	**0.00**	**0.00**	**6.15**
***T. chebula* Retz.**	**0.00**	**0.00**	**0.00**	**0.00**	**5.16**	**7.65**
Wendlandia tinctoria (Roxb.) Dc.	0.00	0.00	0.00	18.79	0.00	0.00

*species in bold are mostly associated with orchids

into logarithmic values. The logarithmic values of population of each site were arranged in relation to multi condition axes (axis 1, 2, and 3) on PCA using software PAST (ver. 2.0). These data were used to calculate the Eigen value based on which co-ordinate axes were represented so as to produce information on the similarity of the girth class preference of orchid types. To test for linearity of population structure amongst the sites, the data was further evaluated to Detrended correspondence analysis.

Results and Discussion

Floristic Composition of Orchids and Phorophytes

A total of 43 orchid species included under 20 genera were recorded from the 240 ha sampled area of Similipal Biosphere Reserve (SBR). Out of these species, 11 were terrestrial and 32 were epiphytic orchids (Table 2). *Vanda tessellata* was very common and was found at all the study sites on all the phorophytes, followed by *Acampe praemorsa* and *Dendrobium aphyllum* (Table 2). Comparison of species richness of epiphytic orchid species amongst the different study sites revealed that site 5 and 6 are species rich sites of the reserve, while site 1 and 2 are the species poor sites of the reserve. Across different study sites, 43 orchid species were observed; further, 52 tree species were recorded. Amongst 52 tree species, only 9 species (about 17.30%) were phorophytes *i.e.* tree species associated with orchid species. The proportion of phorophytes varied amongst different study sites, ranging from 13.46% to 7.69% (Table 3). Mean phorophyte abundance was high at both site 5 and site 6 followed by site 2, site 3, site 1, and site 4 (Table 3). Difference in species richness of both epiphytic and ground orchid species amongst the study sites of the reserve may be due to the difference in protection measure and anthropogenic pressures the study sites received along with the compositional variation and distribution of phorophytes (Table 3). Similar type of observations were also noted by Sinu *et al.* (2011) in forest covers of Western Ghats, India.

IVI of Host Species (Host Species Preference of Orchids)

Importance value Index (IVI) calculations of phorophytes of the reserve showed that *Shorea robusta* was the dominant phorophyte found at all the study sites followed by *Terminalia alata* (Table 4). Besides these two phorophytes, the rest of the phorophyte species were not found at all the selected study sites of the reserve. Association amongst phorophyte species of epiphytic orchids on the basis of IVI differ

Table 4. IVI value of plant species (associated with orchids as host) at six different sites of SBR.

Species	IVI value at					
	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6
Buchanania lanzan Spreng.	0.00	0.00	3.88	18.71	6.94	0.00
Diospyros malabarica (Desr.) Kostel.	0.00	0.00	0.00	21.51	10.12	5.89
Madhuca indica Gmel.	4.77	12.52	30.90	0.00	9.64	0.00
Mangifera indica L.	15.15	25.15	23.04	0.00	10.01	0.00
Schleichera oleosa (Lour.) Oken	0.00	8.18	11.32	0.00	0.00	13.72
Shorea robusta Gaertn. F.	81.59	57.64	77.29	88.76	119.77	98.79
Terminalia alata Heyne ex Roth	18.28	17.27	20.62	20.76	17.74	45.56
T. bellirica (Gaertn.) Roxb.	7.28	13.21	4.46	0.00	0.00	6.15
T. chebula Retz.	0.00	0.00	0.00	0.00	5.16	7.65

Fig. 2. α and β diversity of orchid species across six habitats of SBR.

from site to site. At different study sites, species associated with *Shorea robusta* in decreasing order of IVI were in the order: *Shorea robusta* > *Terminalia alata* > *Mangifera indica* > *Terminalia bellirica* > *Madhuca indica* > *Diospyros malabarica* = *Buchanania lanzan* = *Schleichera oleosa* = *Terminalia chebula* (81.59, 18.28, 15.15, 7.28, 4.77, 0.0, 0.0, 0.0, 0.0, respectively) at site-1; *Shorea robusta* > *Mangifera indica* > *Terminalia alata* > *Terminalia bellirica* > *Madhuca indica* > *Schleichera oleosa* > *Buchanania lanzan* = *Diospyros malabarica* = *Terminalia chebula* (57.64, 25.15, 17.27, 13.21, 12.52, 8.18, 0.0, 0.0, 0.0, respectively) at site-2; *Shorea robusta* > *Madhuca indica* > *Mangifera indica* > *Terminalia alata* > *Schleichera oleosa* > *Terminalia bellirica* > *Buchanania lanzan* > *Diospyros malabarica* = *Terminalia chebula* (77.29, 30.90, 23.04, 20.62, 11.32, 4.46, 3.88, 0.0, 0.0, respectively) at site-3; *Shorea robusta* > *Diospyros malabarica* > *Terminalia alata* > *Buchanania lanzan* > *Madhuca indica* > *Mangifera indica* > *Schleichera oleosa* = *Terminalia bellirica* = *Terminalia chebula*, (88.76, 21.51, 20.76, 18.71, 0.0, 0.0, 0.0, 0.0, 0.0, respectively) at site-4; *Shorea robusta* > *Terminalia alata* > *Diospyros malabarica* > *Mangifera indica* > *Madhuca indica* > *Buchanania lanzan* > *Terminalia chebula* > *Terminalia bellirica* = *Schleichera oleosa* (119.77, 17.74, 10.12, 10.01, 9.64, 6.94, 5.16, 0.0, 0.0, respectively) at site-5 and *Shorea robusta* > *Terminalia alata* > *Schleichera oleosa* > *Terminalia chebula* > *Terminalia bellirica* > *Diospyros malabarica* > *Buchanania lanzan* = *Mangifera indica* = *Madhuca indica* (98.79, 45.56, 13.72, 7.65, 6.15, 5.89, 0.0, 0.0, 0.0, respectively) at site-6. High IVI value of *Shorea robusta* in comparison to other phorophyte species of SBR indicates its high adaptation potential to different environmental conditions of SBR *i.e.* mainly to high moisture content. In addition to this, the dominance nature of *Shorea robusta* may be attributed to their density with big girth class, which increases the relative dominance per hectare. *Shorea robusta,* the dominant phorophyte plant species of SBR has characters like profuse branching system in comparison to the other phorophyte tree species and having fissured bark favoured towards supporting more number of epiphytic orchid species in comparison to others (Table 5). Hietz *et al*. (2002) also described that, the tree with large branches and a more corrugated bark offer better conditions to support epiphytic orchids.

Host Specificity of Epiphytic Orchids

Association of epiphytic orchids with more than one host tree species at SBR, implies that they were the generalist species rather than specialists. All host trees (phorophytes) recorded during the present investigation period were mountain specialist species and characterized by rough bark that made them favourable by orchids for root attachment. This report is in line with the observation of Flores-Palacios and Ortiz-Pulido (2005) that epiphytic orchids are likely to attach to host trees with rough bark rather than smooth one. In addition, the rough bark of phorophytes apparently absorbs more water and nutrients than the smooth bark. Therefore, orchid seeds get lodged in the crevices of bark, more readily and grow because of the available substrate necessary for the growth of seeds.

Table 5. Average number of orchid species at the six sites of different GBH.

Species name	GBH (in cm)				
	30-60	60.1-90	90.1-120	120.1-150	>150
Buchanania lanzan Spreng.	0.33	2.16	0.83	0.0	0.0
Diospyros malabarica (Desr.) Kostel	0.33	1.33	1.0	0.0	0.0
Madhuca indica Gmel.	0.16	1.66	2.0	0.0	0.0
Mangifera indica L.	0.16	1.83	2.5	1.5	1.0
Schleichera oleosa (Lour.) Oken	0.16	1.33	1.5	0.0	0.0
Shorea robusta Gaertn. F.	0.83	2.16	7.0	12.83	5.16
Terminalia alata Heyne ex Roth.	0.83	2.33	4.83	1.83	1.0
T. chebula Retz.	0.66	0.5	0.33	0.0	0.0
T. bellirica (Gaertn.) Roxb.	0.0	1.33	1.83	0.5	0.0

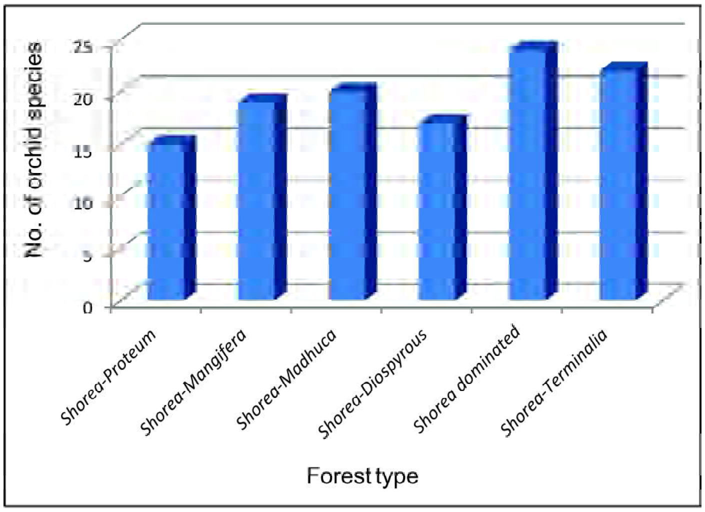

Fig. 3. Number of orchid species in six different forest types of SBR.

Diversity of Epiphytic Orchids

The results pertaining to alpha diversity of epiphytic orchids showed maximum at site 5 and minimum at site 4 (Fig. 3). In all other study sites of the reserve, the alpha diversity of epiphytic orchids was more or less same. High and low values of alpha diversity at site 5 and site 4, respectively of the reserve are due to high and low density of phorophyte species at respective study sites (Table 5). Results of beta diversity indicated that the sites were having beta diversity index ranged from 2.14 to 3.44. High beta diversity was reported at site 6 and low at site 1 (Fig. 3). The range of beta diversity index of the epiphytic orchids measured during the present study is well comparable to the beta diversity of epiphytic orchids at Jharkhand (Kumar, 2007). High beta diversity in such a limited area means that many species had narrow local distributions.

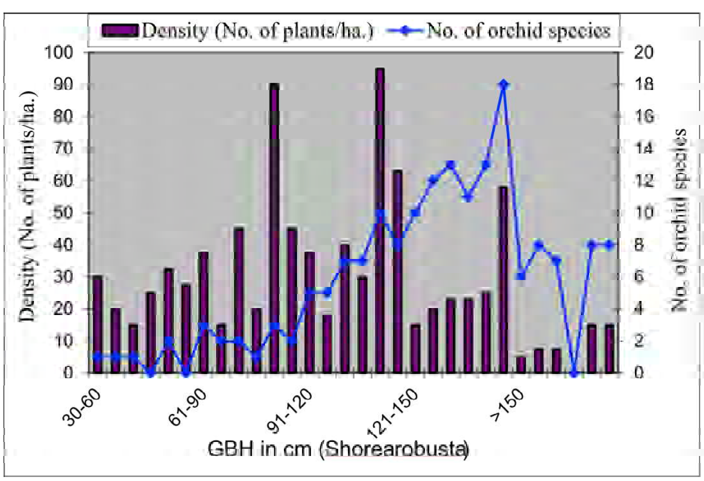

Fig. 4. Girth class preference of orchid species on *Shorea robusta* at six different study sites of SBR.

Girth Class Preference of Orchid Species at Six Different Study Sites of SBR

In analysis of the girth class relation to the orchid species from that nine associated plants (those mostly associated with orchids in nature of SBR) all together the 61-150cm GBH were always better for the luxuriant growth of epiphytic orchids (Fig. 3 to Fig. 12). The girth class of 121-150cm in *Shorea robusta* documented the highest number of orchid species variations were noted down (Fig. 4). The ground orchids were always preferable to growth in sandy and plain land in that of current observation. From girth class distribution of phorophytes at different study sites of SBR, it was found that most of the orchid species preferred girth class of 61-150 cm GBH (Table 5).

Forest Type

Based on important value index of over- storey species at 6 different study sites, forest types were determined. Orchid species were noted down in the particular forest type and the unique habitat of the orchid species was noted down. All the orchid species present in the particular habitat type were marked with star mark and noted down below.

Shorea - *Protium* type; *Shorea* - *Mangifera* type; *Shorea* - *Madhuca* type; *Shorea* - *Diospyrous* type; *Shorea* dominated type; *Shorea* - *Terminalia* type (Fig. 3).

Shorea - Protium Type

This type of forest was seen in the buffer area of Similipal Biosphere Reserve. The surroundings of Lulung, Sitakund, and the Pithabata range forest denoted as the *Shorea-Protium* type of forest area, because the availability of the named phorophytes are higher in that concerned area. The availability of the species as classified amongst epiphytes and terrestrial habitat found in this locality were noted. There was no report of any specific lithophytic orchid, in this locality. All together, 14 epiphytic orchids along with one terrestrial orchid were observed from the site 1. The site 2 of the study area was confined to the Debakund locality which is mostly dominated with Sal and mango tree; this is one of the best localities to grow the wild orchids, because this locality was always humid in condition due to the water fall and is considered under buffer area of SBR. Fifteen epiphytic orchids along with 4 terrestrial orchids were noted down from this *Shorea-Mangifera* type of forest type. Nato area is a part of SBR and denoted as Nato reserve forest area. This forest area is basically situated as buffer and transition zone of SBR. Most of the tribal people were dependent on this area for collection of non-timber forest product for their livelihood. That area is mostly dominated by *Shorea robusta* and

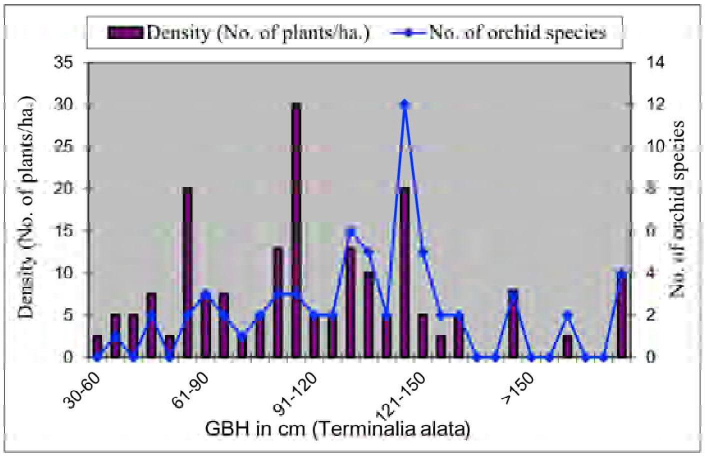

Fig. 5. Girth class preference of orchid species on *Terminalia alata* at six different study sites of SBR.

Madhuca indica plants and comprises 15 epiphytic species along with 4 terrestrial orchid species. One of the orchids, *Pholidota pallida* found in this locality, was a new report for Odisha as earlier workers did not mention it in Orchids of Odisha (Misra, 2004).

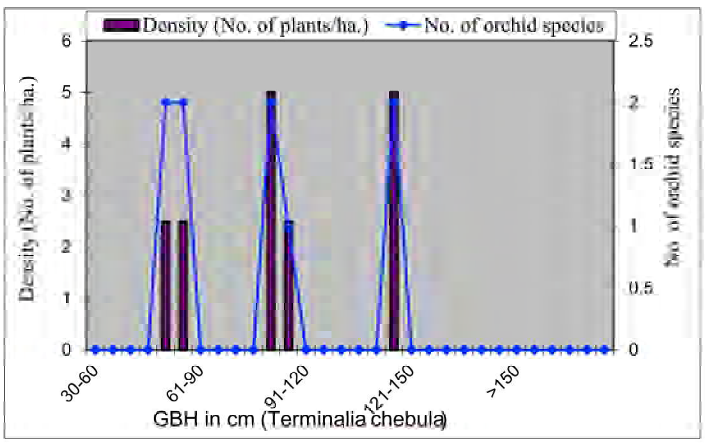

Fig. 6. Girth class preference of orchid species on *Terminalia chebula* at six different study sites of SBR.

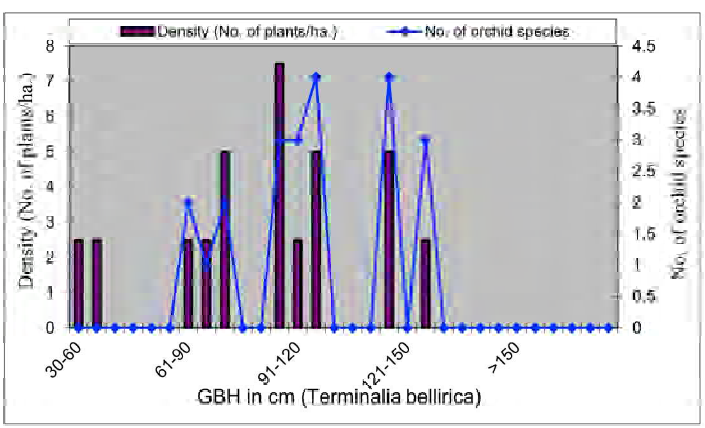

Fig. 7. Girth class preference of orchid species on *Terminalia bellirica* at six different study sites of SBR.

Shorea - Diospyrous Type

Site 4 had a less density of phorophytes, resulting less number of epiphytic orchids. Only 6 epiphytic orchids were collected from this locality, but except *Tainia hookeriana*, all the ground orchids were identified in this locality. The sandy soil along with small water stream was the most favorable condition for this type of ground orchids. *Geodorum densiflorum*, *G. recurvum*, *Habenaria commelinifolia,* and *H. roxburghii* were the four ground species confined to only that site 4 areas of the current study. Furthermore, *Habenaria roxburghii* is a new report for Mayurbhanj district.

Shorea Dominated Type

The natural condition of Site 5 (Gurguria) was cold and humid due to river bank. The tourist place Gurguria in SBR was dominated by *Shorea robusta* plants and the area side to the forest bit is well conserved. The ultimate conserve of phorophytes increased the species diversity of the epiphytic orchids. Twenty one epiphytic orchids along with three ground orchids were noted from this area. One rare ground orchid, *Tainia hookeriana* was found in this site only.

Shorea - Terminalia Type

The core area of SBR was always more conserved rather than the periphery region. Site 6 was rich in biodiversity and also rich in phorophytes. All together, 21 epiphytic orchids along with one terrestrial orchid were documented from this locality. One epiphytic orchid, *Dendrobium regium* was only reported from this locality.

Girth Class Preference of Orchid Species at Six Different Study Sites of SBR

In analysis of the girth class relation to the orchid species from nine associated plants (those mostly associated with orchids in nature of SBR), all together the 61-150cm GBH were always better for the luxuriant growth of epiphytic orchids (Figs. 4-12). The girth class of 121-150cm in *Shorea robusta* documented the highest number of orchid species variations were noted down (Fig. 3). The ground orchids were always preferable to growth in sandy and plain land. From girth class distribution of phorophytes at different study sites of SBR, it was found that most of the orchid species preferred girth class of 61-150 cm GBH (Table 4).

Community Ordination Analysis

Principal Components Analysis (PCA) was used for the reduction of information on a large number of

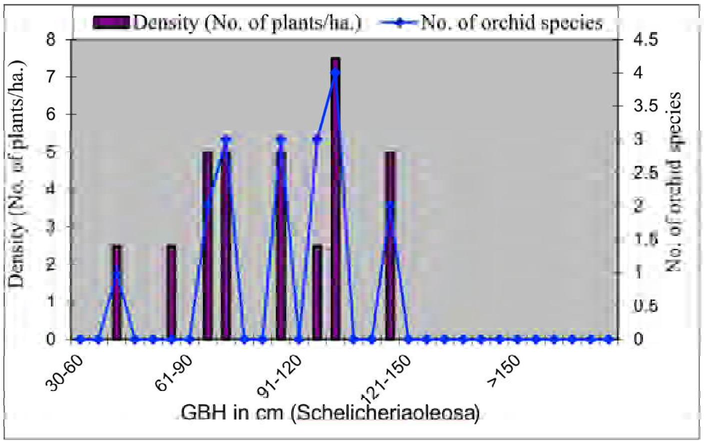

Fig. 8. Girth class preference of orchid species on *Schelicheria oleosa* at six different study sites of SBR.

variables into a small set. The presence of variables (population of sampling units) in different axis provided maximum information about the ecological similarities amongst the sites. Each PCA axis or component correspond to an Eigen value is the variance accounted for, by the axes. The Eigen values are extracted in the descending order of magnitude and the corresponding PCA components represented greater to lesser amount variation in the matrix (Muthukrishna *et al*., 2012). The values of PCA as co-relation amongst the sites were represented (Fig. 6). The PCA ordination plotting of Component 1 vs. Component 2 indicated that the data of the fungal population sites showed highest positive values for Chahala-1 and Chahala-2 around 0.9 to be static and more significantly modulated the fungal population in this ecosystem. On the other hand, Pithabat-2 and Bareipani were positioned towards the negative sides of the axis and values were less to be -0.40289 and -0.64711, respectively. Whereas, variation in the fungal population was observed in both while studying in spread and pour plates. Plotting Component-1 vs. Component-3 also showed relatively same effect as that of spread plate and pour plate methods for encountering the fungal population. But, the summer population and winter population fall on alternate sides when Component-1 vs. Component-3 and Component-2 vs. Component-3 were plotted. Moreover, the populations of fungi in Chahala-2 and Joranda-1 sites were depicted on same sides of plotting representing less variations between the sites.

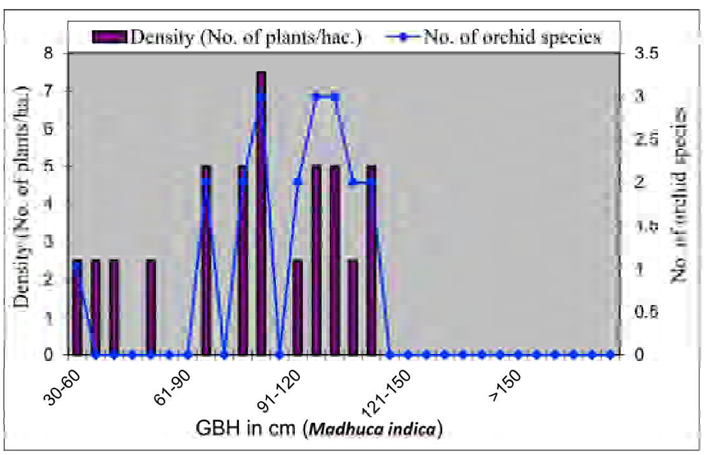

Fig. 9. Girth class preference of orchid species on *Madhuca indica* at six different study sites of SBR.

Detrended Correspondence Analysis

Presently, an attempt has been to find out the linearity distribution of fungal population amongst the sampling sites. Detrended correspondence analysis plotting axis 1 and axis 2 and axis 3 indicated non-linear arrangement of the samples. The values of the first three axis obtained by computing the detrended correspondence analysis was proved. In pictorial representation (Fig. 7), all the different sites observed were plotted on sheet, suggested non linearity distribution of taxa amongst various sampling sites.

Population Decline of Both Epiphytic and Terrestrial Orchids

The mortality rate always depends on the natural death or by the natural heritage and by the interference by the animals along with the human. Natural disaster and tree mortality ultimately impact on the epiphytic orchids observed in the current study. Though orchids persist on dead plant for a long period but, after the bark detached from that tree trunk, the orchids associated with that bark also fall on the ground. Furthermore, this may simply reflect the strong, stochastic influence

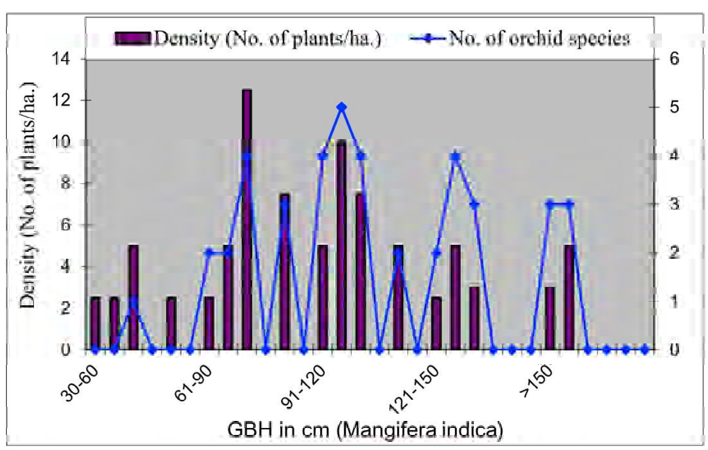

Fig. 10. Girth class preference of orchid species on *Mangifera indica* at six different study sites of SBR.

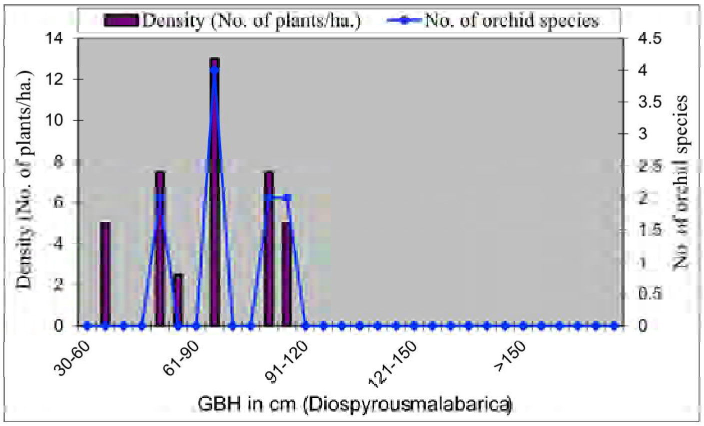

Fig. 11. Girth class preference of orchid species on *Diospyrous malbarica* at six different study sites of SBR.

of branch and tree mortality on the demography of epiphytes (Hietz, 1997; Zotz, 2004; Zotz and Schmidt, 2005).

Arboreal species and herbivores may also be responsible for decline in the natural populations of

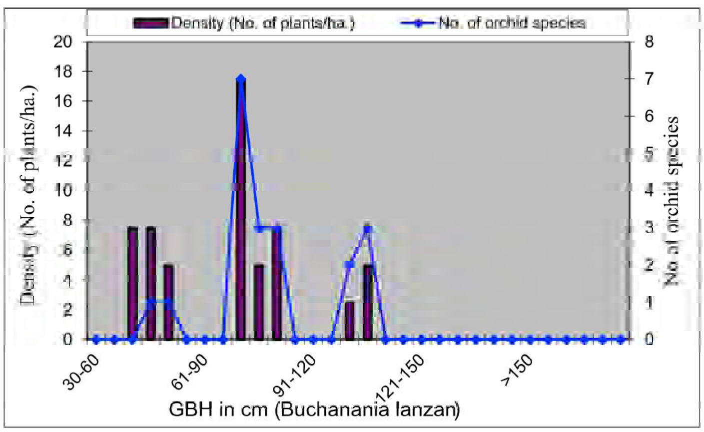

Fig. 12. Girth class preference of orchid species on *Buchanania lanzan* at six different study sites of SBR.

orchids in SBR. The giant squirrel was found as the most common arboreal species to consume the epiphytic orchid shoots as a common food. Similarly, wild boars also dig out the tubers of ground orchids, ultimately resulting in decrease of terrestrial species, in nature. Similar type of observations were also noted down by Swarts and Dixon (2009). However, it was observed that the higher humidity and the natural conditions of core area forest were favourable for growth of wild orchids. Simultaneously, the anthropogenic pressures were less. The ground orchid species diversity in Bhimkund was higher than found at other five sites, due probably to appropriate soil conditions and less interference wild animal at this locality.

Conclusion

The present data indicates that the population dynamics of orchid flora is directly proportional to the density of phorophytes in the natural habitat. Further, the appropriate girth class of phorophytes affects the growth and number of epiphytic orchid flora. As the terrestrial orchids are always at the risk of extinction due mainly to several environmental factors and also animal interference, the phorophytes, and the canopy coverage plays a major role for orchid conservation, in the forest ecosystem.

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References

Annasevalam, J. and N. Parthasarathy. 2001. Diversity and distribution of herbaceous vascular epiphytes in a tropical evergreen forest at Varagalaiar, Western Ghats, India. *Biodivers. Conserv.*, **10**: 317-29.

Dash. 2001. *Fundamental of Ecology*. McGrew-Hill Education (India) Pvt. Limited, Noida, India.

Flores-Palacios, A. and R. Ortiz-Pulido. 2005. Epiphyte orchid establishment on termite carton trails. *Biotropica*, **37**: 457-61.

Hietz, P. 1997. Population dynamics of epiphytes in a Mexican humid montane forest. *J. Ecol.*, **85**: 767-77.

Hietz, P., J. Ausserer, and G. Schindler. 2002. Growth, maturation and survival of epiphytic bromeliads in a Mexican humid montane forest. *J. Trop. Ecol.*, **18**: 177-91.

Jalal, J. S. 2005. *Systematics, Phytogeography and Habitat Ecology of Orchids of Uttaranchal*. Ph.D. Thesis. Kumaun University, Uttarakhand, India.

Kershaw, K. R. 1973. *Quantitative and Dynamic Plant Ecology*. Edward Arnold, London, U.K.

Kumar, P. 2007. *Systematics and Some Aspects of Ecology of Orchids in Jharkhand State, India*. Ph.D. Thesis, Forest Research Institute (Deemed University), Dehradun, India.

Misra, R. 1968. *Ecological Workbook*. Oxford and IBH Publishing Company, Calcutta, India.

Misra, S. 2004. *Orchids of Orissa*. Bishen Singh and Mahendra Pal Singh, Dehradun, India.

Mueller-Dombois, D. and H. Ellenberg. 1974. *Aims and Methods of Vegetation Ecology*. Wiley, New York, U.S.A.

Muthukrishnan, S., K. P. Sanjayan, and H. K. Jahir. 2012. Species composition, seasonal changes and community ordination of alkalotolerant micro fungal diversity in a natural scrub jungle ecosystem of Tamil Nadu, India. *Mycosphere*, **3**: 92-109.

Saxena, H. O. and M. Brahamam. 1995. *The Flora of Orissa*. Orissa Forest Department Corporation, Bhubaneswar, India.

Saxena, A. K. and J. S. Singh. 1984. Tree population structure of certain himalayan forest associations and implications concerning their future composition. *Vegetatio*, **58**: 61-69.

Sinu, P. A., G. Kuriakosa, and K. Chandrashekara. 2011. Epiphytic orchid diversity in farmer-managed Soppinabetta forests of Western Ghats: Implicating for conservation. *Curr. Sci.*, **101**(10): 1337-46.

Swarts, N. D. and K. W. Dixon. 2009. Terrestrial orchid conservation in the age of extinction. *Ann. Bot.*, **104**(3): 543-56.

Vane-Wright, R. I., C. J. Humphries, and P. H. Williams. 1991. What to protect? Systematics and the agony of choice. *Biol. Conser.*, **55**: 235-54.

Vij, S. P., N. Shekhar, S. K. Kashyap, and A. K. Garg. 1983. Observations on the orchids of Nainital and adjacent hills in the Central Himalaya (ecology and distribution). *Res. J. Bull. Punjab University*, **34**(3): 63-76.

Whittaker, R. H. 1972. Evolution and measurement of species diversity. *Taxon*, **21**(2-3): 213-51.

Zotz, G. 2004. Long-term observation of the population dynamics of vascular epiphytes. *In: Ergebnisse Weltweiter O¨ Kologischer Forschung- Results of Worldwide Ecological Studies* (eds. S. W. Breckle, B. Schweizer, and A. Fangmeier) pp. 119-27. Verlag Gu¨nter Heimbach, Stuttgart, Germany.

Zotz, G. and P. Hietz. 2001. The ecophysiology of vascular epiphytes: Current knowledge, open questions. *J. Experiment. Bot.*, **52**: 2067-78.

Zotz, G. and G. Schmidt. 2005. Population decline in the epiphytic orchid *Aspasia principissa*. *Biol. Conserv.*, **129**: 82-90.