Floristic diversity of climbing plants in tropical forests of Similipal Biosphere Reserve, Odisha, India

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Abstract

Climbers influence the diversity and composition of forest ecosystem immensely. We have investigated the floristic composition of climbing plants in tropical forests of Similipal Biosphere Reserve (SBR), Odisha, India. A total of 120 climber plant species belonging to 74 genera and 33 families were documented in all forests. Among families, the most speciose families were Fabaceae (25 species) and Convolvulaceae (22 species) followed by Cucurbitaceae (11 species), Vitaceae (8 species), Dioscoreaceae (7 species) etc. Similarly, dominant genera were Ipomoea possessing the highest number of species i.e., 9 species followed by Dioscorea (7 species), Vigna (6 species) and Cissus (4 species) etc. There was a remarkable difference noted in the structure and climbing mechanism of different climbers. The climbing plants diversity of SBR not only contributing to the overall forest biodiversity significantly but also maintain the ecological balance of the whole ecosystem. Climbers are the major resource of economic value in and around the biosphere reserve and thus their use and sustainable management must be given principal attention.

Keywords: climber’s diversity; climbing mode; conservation; ecosystem; tropical forests

Abbreviations: SBR- Similipal Biosphere Reserve; WV- Woody Vines; HV- Herbaceous Vines, PV- Parasitic Vines

Introduction

Tropical forest constitutes 52% of the total forest of the globe and it is the most important ecosystem for biodiversity. Lianas are most diverse and abundant group of plants in the world representing nearly 25% of the woody stem density and species diversity in tropical forests (Gentry, 1991a). In the Indian subcontinent, 15010 km² of the area is occupied by tropical wet evergreen forests, which constitute about 10% of total tropical forest cover in the country (IIRS, 2002). Climbers are the plants which grow by climbing on bigger plants and different objects with the help of their tendrils. Tendrils are the special structures present in climbers which provides support for climbing over other. The climbers, creepers, vines and lianas are some separate groups of flora, which are differentiated based on their climbing habit and nature of stem organisation. Twiners are the specialised climbers which use their stem and leaves as tendrils and coils around a plant. The stems are slender and due to their twining habit, these are called as twiner or stem climber. Creepers are another group of life forms different from others because they don’t grow vertically, they grow horizontally and spread. Lianas are the woody vines which have a long and woody stem and sometimes climb from one plant to another with the
help of tendrils, sucker root following the sunlight. Lianas are one of the most important understudied life forms found mainly in tropical forests although usual in many forests of the world (Schnitzer and Bongers, 2002). The great ecological and functional differences among the species are described by the variation in species composition of lianas in different forests. Despite of having similar forms of growth between lianas, they vary in functional traits like procedure of climbing (Putz, 1984; Putz and Mooney, 1991), size of flower and type of diaspore (Gentry, 1991a; Bullock, 1995; Cai et al., 2009) and the need of light (Putz, 1984; Baars et al., 1998; Gianoli et al., 2010). Some biotic and abiotic factors like annual rainfall, seasonal rainfall, fertility of soil, structure of forest, regimes of disturbances represent the species diversity, abundance and distribution of lianas (Ibarra-Manriquez and Martinez-Ramos, 2002; Schnitzer and Bongers, 2002; Poulsen et al., 2005; Schnitzer et al., 2005; Addo-Fordjour et al., 2009a, 2009b; DeWalt et al., 2010; Toledo, 2010; Addo-Fordjour et al., 2012).

Lianas cause compression and sometimes squeeze the host plant, as a result, the water movement, sap moment and rate of other physical and biological processes inside the host plant decreases (Dalling et al., 2012). Hence, constriction of a long time on the plant may cause the death of the host plants. They damage physically the young plants and causes death whereas in case of matured plants they affect adversely both physically and compete with them in their biological processes. Lianas compete with host plants in nutrition, absorption of light and water and the growth rate of host plant decreases than the normal rate (Maria et al., 2017). They cause bending and squeezing of plants, as a result, the timber value of the plant decreases. Every living and non-living object produce both the positive and negative impacts on their surrounding environment. In this manner lianas also have both positive and negative impacts on surrounding environment. If we consider both the impacts of lianas, it has a huge positive impact on living organisms and the negative impacts are very low (Bonger et al., 2002). Besides adverse effects of lianas over the trees on which they climb, lianas cannot be neglected due to their ethnomedicinal values and importance in ecosystem functioning (Schnitzer and Bongers, 2002). They fulfill various purposes of human beings by providing edible fruits, vegetables and also have a great medicinal value. In distant or remote areas where the various advanced products and modern western medicines are unavailable and remain unreached, lianas play an important role for survival (Abbiw, 1990; Van Andel, 2000; Arnold and Ruiz Perez, 2001). But in some regions due to rapid human interference and exploitation, many of the valuable plants including lianas are coming towards extinction.

There are so many floristic, ethnobotanical and phytosociological studies were done in Similipal Biosphere Reserve (SBR) in recent past (Behera, 2006; Mishra et al., 2008; Dash and Behera, 2013; Panda, 2014). Most of the studies emphasized on trees, medicinal plants and other groups of plants in general. However, a study on the climber, in particular, has not been done so far. Therefore, here is an attempt taken to study in detail on climber diversity in SBR along with its uses, habit and climbing mode. This data will be helpful for gaining knowledge on climbers and their values in forest ecosystems, which may have implications for conservation of climbers in tropical forests.

**Materials and Methods**

**Study area**

Similipal Biosphere Reserve (SBR) is located in Mayurbhanj district of Odisha, India (Figure 1). It extends between 20° 17' to 22° 34' N. latitude and 85° 40' to 87° 10’ E. longitude, located in the centre of Mayurbhanj district and altitude ranges between 40 m to 1166 m above the sea level. The temperature here becomes minimum at 2 °C during winter and becomes maximum at 43 °C during summer. The average rainfall is 2200 mm. It stretches over an area of 5569.00 km² divided into a core area of ca 1194.75 km², buffer area ca 1335.88 km² and transition area ca 3038.39 km². It is a portion of Chhotanagpur biotic province of Deccan plateau and constituted in Mahanadian Biogeographic region. SBR is known as a prominent ecological hotspot and is one of the eighteen biosphere reserves of India because of its rich diversity and cultural significance.
Similipal exerts a large influence over the climatic conditions of Odisha and its neighbourhood and is an asset of floristic diversity of the state. Hence, it is also called as Himalayas of Odisha.

![Figure 1. Map of Similipal Biosphere Reserve (SBR), Odisha, India](image)

The largest compact Sal bearing forest, Similipal is a Tiger Reserve, a proposed National Park, a Sanctuary and a Biosphere Reserve. Major rivers like Budhabalanga, Salandi, Baitarani and many rivulets flow through Similipal. It constitutes floral and faunal elements both from the Western Ghats and Eastern Himalaya. The forest supports more than 1200 plant species, with 300 species of medicinal plants and 94 species of Orchids (Sexena and Brahmam, 1989; Misra, 2004). It constitutes 8% of Orchids and 7% of flowering plants of the whole country, India. *Shorea robusta* Gaertn., *Terminalia tomentosa* Wight & Arn., *Haldinia cordifolia* (Roxb.) Ridsdale, *Anogeissus latifolia* (Roxb. Ex DC) Wall. Ex Bedd, *Schleichera oleosa* (Lour.) Merr. etc. are the main tree species of SBR.

**Field method and data collection**

The objective of the present study is to survey and document the diversity of climbers in SBR. The various species of lianas were collected from different parts of SBR with the help of local people and forest guards who had maximum knowledge about this. We had visited different parts of Similipal Biosphere Reserve from December 2017 to March 2018 for the collection of specimens and its uses practised by the local indigenous people. We have also tried to investigate the economic importance of the climbing plants by consulting the local communities residing in and around the biosphere reserve. The photographs of some specimens were taken as good as possible to figure out a clear view of those plants (Figure 3). The plant materials were collected in plastic bags and handled very carefully. The specimens were identified with the help of regional floras (Saxena and Brahmam, 1994-1996; Haines, 1921-1925; Gamble and Fischer, 1915-1935) and other available literatures. Further, the specimens were processed and preserved in the herbarium of
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Biosystematics laboratory, Department of Botany, Maharaja Sriram Chandra Bhanja Deo University, Baripada, Odisha. All the species were enumerated with its botanical name, family, local name, habit, climbing mode, and uses.

**Results**

The present study documented a total of 120 climber plant species belonging to 74 genera and 33 families (Table 1). Among the families, the most speciose families were Fabaceae (25 species) followed by Convolvulaceae (22 species), Cucurbitaceae (11 species), Vitaceae (8 species), Dioscoreaceae (7 species) etc. Similarly, dominant genera were Ipomoea possessing the highest number of species i.e., 9 species followed by Dioscorea (7 species), Vigna (6 species), Clematis (3 species) and Cissus (3 species) etc. Out of 120 climbing plant species, 62 species were woody vines, 57 species were herbaceous vines and one parasitic vine representing 52.10%, 46.05% and 0.83%, respectively. The climbing plants of SBR were classified according to their habits i.e. woody vines, herbaceous vines and parasitic vines (Table 1). Local communities were using these climbers for various purposes. It had been observed that out of 120 species, 48 species had medicinal properties (39.669%), 16 species are edible (13.34%), 13 species had ornamental value (10.83%) and the remaining 43 had other uses (35.83%). The enumerated climbing plants showed 6 different climbing mode mechanisms which were stem twiners (63.02%), tendril climbers (21.84%), hook climbers (3.36%), straggler unarmed (8.4%), straggler armed (2.52%) and root climbers (0.84%) (Figure 2).

![Figure 2](image-url). Percentage of different climbing modes found in climbers of SBR, Odisha, India

With the compilation of survey data and available literatures, we found a total of 97 species which had medicinal value. Out of these, 14 species were directly taken as food as well. The species which had both medicinal as well as nutritional values were Lasia spinosa (L.) Thw., Basella alba L., Ipomoea aquatic Forsk., Dioscorea oppositifolia L. etc. There were 24 species found edible in the study. There were 5 species in the study generally used in domestic and ornamental aspects. Ipomoea turbinata Lag. was the only species which is edible as well as ornamental value. Bauhinia vahlii W & A. was the only species which had house hold uses in...
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preparation of ropes. The present study could not report any economic value for 8 species and such information is also lacking in the previous literature for these species. The species without any economic values were *Rhaphidophora glauca* (Wall.) Schott., *Ipomoea barkerioides* (Choisy) Benth. Ex C.B.Cl., *Ipomoea sinensis* (Desr.) Choisyssp., *Dolichos trilobus* L., *Mucuna nigricans* (Lour.) Steud., *Vigna pilosa* Baker., *Clematis roylei* Rehder, and *Ampelocissus divaricata* (Wall. ex Lawson) Planch.

The most abundant climber species in the study area were *Combretum roxburghii* Spreng. (Combretaceae), *Bauhinia vahlii* W. & A. (Fabaceae), *Mikania micrantha* Kunth (Asteraceae), *Hemidesmus indicus* (L.) R. Br. (Apocynaceae), *Asparagus racemosus* Willd. (Asparagaceae) etc. The rare climber species were *Gnetum ula* Brongn. (Gnetaceae), *Thalictrum foliolosum* DC. (Ranunculaceae), *Smilax perfoliata* Lour. (Smilacaceae) etc. Among the studied species, four are considered as locally threatened according to the CAMP report (Ved et al., 2007). The species were *Celastrus paniculatus* Willd. (Celastraceae), *Gnetum ula* Brongn. (Gnetaceae), *Paederia foetida* L. (Rubiaceae), *Pueraria tuberosa* (Roxb. ex Willd.) DC. (Fabaceae), *Scindapsus officinalis* (Roxb.) Schott. (Araceae) which are coming under the vulnerable category.

### Table 1. List of climbers in SBR, Odisha, India

| Family            | Scientific Name                        | Local Name | Habit | Climbing mode | Economic importance  |
|-------------------|----------------------------------------|------------|-------|---------------|----------------------|
| Acanthaceae       | *Thunbergia fragrans* Roxb.             | Chakrakedar| HV    | Stem Twiner   | Ornamental           |
|                   | *Aganosma caryophyllata* (Roxb.exSims.) G.Don. | Gandhamalati | WV    | Stem Twiner   | Medicinal            |
|                   | *Cryptolepis dubia* (Burm.f.) M.R. Almeida | Dudhi      | WV    | Stem Twiner   | Medicinal            |
|                   | *Hemidesmus indicus* (L.) R. Br.        | Thapa      | HV    | Tendril Climb | Medicinal            |
|                   | *Ichnocarpus frutescens* (L.) W.T.Aiton | Dudhi lata | HV    | Stem Twiner   | Medicinal            |
|                   | *Tylophora indica* (Burm. f.) Merr.     | Banbanka   | HV    | Stem Twiner   | Medicinal            |
| Apocynaceae       | *Lasia spinosa* (L.) Thw.               | Kanta Saru | HV    | Stem Twiner   | Edible & Medicinal   |
|                   | *Rhaphidophora glauca* (Wall.) Schott.  | -          | WV    | Stem Twiner   | -                    |
|                   | *Scindapsus officinalis* (Roxb.) Schott. | Girudhuni  | WV    | Root Climbers | Medicinal            |
| Aristolochiaceae  | *Aristolochia indica* L.                 | Iswar Mula | HV    | Stem Twiner   | Medicinal            |
| Asclepiadaceae    | *Pergularia daemia* (Forsk.)Chiov.      | Iturhi     | HV    | Stem Twiner   | Medicinal            |
| Asparagaceae      | *Asparagus racemosus* Willd.            | Iswar Jata | HV    | Stem Twiner   | Medicinal            |
| Asteraceae        | *Mikania micrantha* Kunth               | -          | HV    | Stem Twiner   | Medicinal            |
| Basellaceae       | *Basella alba* L.                       | Poi        | HV    | Stem Twiner   | Edible & Medicinal   |
| Bignoniaceae      | *Pyrostegia venusta* (Ker Gawl.) Miers  | -          | HV    | Tendril Climb | Medicinal            |
| Capparaceae       | *Capparis zeylanica* L.                 | Sabbi      | WV    | Straggler armed | Medicinal            |
| Celastraceae      | *Celastrus paniculatus* Willd.          | Pengu      | WV    | Stem Twiner   | Medicinal            |
| Family        | Genus                                    | Species                | Type        | Habitat  | Classification          |
|--------------|------------------------------------------|------------------------|-------------|----------|-------------------------|
| Combrtaceae  | *Combretum roxburghii* Spreng.           | Atundi WV              | Stem Twiner | Medicinal |                         |
|              | *Argyreia bella* (C.B.C.I.) Raizada.     | - WV                   | Stem Twiner | Medicinal |                         |
|              | *Argyreia daltonii* C.B.C.I.             | - WV                   | Stem Twiner | Medicinal |                         |
|              | *Evolulus nummularius* (L.) L.           | - HV                   | Stem Twiner | Medicinal |                         |
|              | *Ipomoea aquatica* Forrsk.               | Kalma Saga HV          | Stem Twiner | Edible & Medicinal | |
|              | *Argyreia nervosa* (Bur. f.) Bojer       | Mundanoi HV            | Stem Twiner | Medicinal |                         |
|              | *Convolvulus arvensis* L.                | - HV                   | Stem Twiner | Medicinal |                         |
|              | *Cuscuta reflexa* Roxb.                  | Nirmuli PV             | Stem Twiner | Medicinal |                         |
|              | *Erycibe paniculata* Roxb.               | Joda Koli WV           | Stem Twiner | Edible & Medicinal | - |
|              | *Ipomoea barlerioides* (Choisy) Benth ExC.B.C.I. | - HV                   | Stem Twiner | -         |                         |
|              | *Ipomoea carneja* Jacq. ssp.             | Amari WV               | Stem Twiner | Edible & Medicinal | |
|              | *Ipomoea criocarpa* R.Br.                | Panioi WV              | Stem Twiner | Edible & Medicinal | |
|              | *Ipomoea nil* (L.) Roth.                 | Khondo HV              | Stem Twiner | Medicinal |                         |
|              | *Ipomoea pes-tigridis* L.                | Billeinandi HV         | Stem Twiner | Medicinal |                         |
|              | *Ipomoea quamoclit* L.                   | - HV                   | Stem Twiner | Ornamental |                         |
|              | *Ipomoea bitilora* (L.) Pers.            | - HV                   | Stem Twiner | -         |                         |
|              | *Ipomoea turbinata* Lag.                 | Bina WV                | Stem Twiner | Edible & Ornamental | |
|              | *Merremia hederacea* (Bur. f.) Hallier f. | - HV                   | Stem Twiner | Medicinal |                         |
|              | *Merremia hirta* (L.) Merr.              | - HV                   | Stem Twiner | Medicinal |                         |
|              | *Merremia tridentata* (L.) Hallier f.    | - HV                   | Stem Twiner | Medicinal |                         |
|              | *Merremia umbellata* (L.) Hallf.         | Paninoi HV             | Straggler unarmed | Edible & Medicinal | |
|              | *Merremia vitifolia* (Burm.f.) Hall.f.   | - WV                   | Stem Twiner | Medicinal |                         |
|              | *Operculina turpethum* (L.) Silva Manso  | Dudhaloma WV           | Stem Twiner | Medicinal |                         |
| Cucurbitaceae| *Coccinia grandis* (L.) Voigt            | Kunduri HV             | Tendril Climber | Edible |                         |
|              | *Cucumis melo* L.                       | Kharbhuj HV            | Tendril Climber | Medicinal |                         |
|              | *Cucumis sativus* L.                     | Kakudi HV              | Tendril Climber | Medicinal |                         |
| Species                                      | Common Name     | Habitat | Type     | Use          |
|----------------------------------------------|-----------------|---------|----------|--------------|
| *Cucurbita maxima* Duchesne                  | Kakharu         | HV      | Tendril  | Climber     | Medicinal   |
| *Diplocyclos palmatus* (L.) C. Jeffrey       | Kaudia          | WV      | Tendril  | Climber     | Medicinal   |
| *Lagenaria siccaria* (Molina) Standl.         | Lau             | HV      | Tendril  | Climber     | Medicinal   |
| *Momordica charantia* L.                     | Kalara          | HV      | Tendril  | Climber     | Medicinal   |
| *Mukia maderaspatana* (L.) M.Roem.           | Bilari          | WV      | Tendril  | Climber     | Medicinal   |
| *Trichosanthes cucumerina* L.                | Chichendra      | HV      | Tendril  | Climber     | Medicinal   |
| *Trichosanthes dioica* Roxb.                 | Patal           | HV      | Tendril  | Climber     | Medicinal   |
| *Trichosanthes tricuspidata* Lour            | Mehankala       | WV      | Tendril  | Climber     | Medicinal   |

| Species                                      | Common Name     | Habitat | Type     | Use          |
|----------------------------------------------|-----------------|---------|----------|--------------|
| *Dioscorea glabra* Roxb.                     | Kanta Alu       | HV      | Stem     | Toner        | Edible      |
| *Dioscorea hamiltonii* Hook.f.               | Suta Alu        | HV      | Stem     | Toner        | Edible &    | Medicinal   |
| *Dioscorea hispida* Dennst.                  | Bainya Alu      | HV      | Stem     | Toner        | Medicinal   |
| *Dioscorea oppositifolia* L.                 | Pitli Kanda     | HV      | Stem     | Toner        | Edible &    | Medicinal   |
| *Dioscorea pentaphylla* L.                   | Mundi Kanda     | HV      | Stem     | Toner        | Edible &    | Medicinal   |
| *Dioscorea puber* Bl.                        | Kosa Kanda      | HV      | Stem     | Toner        | Edible      |
| *Dioscorea wallichii* Hook.f.                | Pita Alu        | HV      | Stem     | Toner        | Edible      |

| Species                                      | Common Name     | Habitat | Type     | Use          |
|----------------------------------------------|-----------------|---------|----------|--------------|
| *Abrus precatorius* L.                       | Runja           | HV      | Stem     | Toner        | Medicinal   |
| *Cajanus crassus* (King) Maesn               | Bankandul       | WV      | Stem     | Toner        | Medicinal   |
| *Bauhinia vahlii* W.&A.                      | Siali Lata      | WV      | Straggler| unarmed      | Domestic    |
| *Butea superba* Roxb.                       | Noi Palas       | WV      | Straggler| unarmed      | Medicinal   |
| *Cajanus scarabaeoides* (L.) Thouars         | Arhar           | HV      | Stem     | Toner        | Medicinal   |
| *Clitoria ternatea* L.                      | Aparajita       | WV      | Stem     | Toner        | Medicinal   |
| *Derris indica* (Lam.) Bennet.              | Karanjo         | WV      | Stem     | Toner        | Medicinal   |
| *Derris scandens* (Roxb.) Benth.            | Kentia          | WV      | Stem     | Toner        | Medicinal   |
| *Dolichos trilobus* L.                      | -               | HV      | Stem     | Toner        | -           |
| *Entada theedi* Spreng.                     | Hanuman Mara    | WV      | Stem     | Toner        | Medicinal   |
| *Lablab purpureus* (L.) Sweet ssp.           | Simbo           | WV      | Stem     | Toner        | Medicinal   |
| Family                | Genus                     | Species                                      | Voucher | County | Form       | Genus       | County | Description       |
|----------------------|---------------------------|----------------------------------------------|---------|--------|------------|-------------|--------|-------------------|
| **Gnetaceae**        | *Gnetum ula*              | *G. ula* Brongn.                            | Mirig Lendi | WV Straggler unarmed Medicinal |
| Lygodiaceae          | *Lygodium flexuosum* (L.) Sw. | *L. flexuosum* Sw.                          | Kala Mahajal | HV Stem Twiner Medicinal |
|                      | *Lygodium scandens* Sw.   | *L. scandens* Sw.                           | -       | HV     | Stem Twiner Medicinal |
| Menispermaeae        | *Cissam pelospareira* L. var. *hirsuta* (DC.) Forman. | *Cissam pelospareira* L. var. *hirsuta* (DC.) Forman. | -       | HV     | Stem Twiner Medicinal |
|                      | *Stephania japonica* (Thunb.) Miers. | *S. japonica* (Thunb.) Miers.              | Sondhimali | HV     | Stem Twiner Medicinal |
|                      | *Tinospora cordifolia* (Willd.) Miers. | *T. cordifolia* (Willd.) Miers.          | Tihadi | WV     | Stem Twiner Medicinal |
| Primulaceae          | *Embelia ribes* Burm.f.   | *E. ribes* Burm.f.                          | -       | WV     | Straggler unarmed Medicinal |
|                      | *Embelia tsjeriam-cottam* A. DC. | *E. tsjeriam-cottam* A. DC.          | Nununia | WV     | Stem Twiner Medicinal |
| Nyctaginaceae        | *Boerhavia diffusa* L.   | *B. diffusa* L.                            | Goudapuruni | HV Hook Climber Edible & Medicinal |
|                      | *Bougainvillea glabra* Willd. | *B. glabra* Willd.                        | -       | WV     | Hook Climber Medicinal |
|                      | *Bougainvillea spectabilis* Willd. | *B. spectabilis* Willd.                   | Kagaji Phula | WV Hook Climber Edible & Medicinal |
| Olacaceae            | *Olan scopens* Roxb.     | *O. scopens* Roxb.                         | -       | WV     | Straggler unarmed Medicinal |
| Family          | Scientific Name              | Common Name | Type          | Status       |
|-----------------|------------------------------|-------------|---------------|--------------|
| Oleaceae        | *Jasminum arborescens* Roxb. | Banamali    | WV Twiner     | Medicinal    |
|                 | *Jasminum azoricum* L.       | -           | WV Twiner     | Ornamental   |
|                 | *Jasminum scandens* Vahl.    | Bana Malli  | WV Twiner     |              |
| Passifloraceae  | *Passiflora foetida* L.      | Bistpi      | HV Climber    | Medicinal    |
| Piperaceae      | *Piper triicum* Roxb.        | Chai katha  | WV Twiner     | Medicinal    |
| Ranunculaceae   | *Clematis gouriana* Roxb. ex DC. | Bariamal    | WV Straggler unarmed | Medicinal |
|                 | *Clematis roylei* Rehder.    | Ganamari    | WV Straggler unarmed | -          |
|                 | *Clematis smilacifolia* Wall. | -           | WV Straggler unarmed | Medicinal |
|                 | *Thalictrum foliolosum* DC.  | Bharda      | WV Tendril Climber | Medicinal    |
| Rubiaceae       | *Paederia foetida* L.        | Prasaruni   | WV Twiner     | Medicinal    |
| Rhamnaceae      | *Ventilago denticulata* Willd. | Kantamali   | WV Stem Twiner | Medicinal    |
|                 | *Ziziphus oenopolia* (L.) Mill. | Kanakoli    | WV Straggler armed | Medicinal   |
|                 | *Ziziphus rugosa* Lam.       | Kanteikali  | WV Straggler armed | Medicinal   |
| Rutaceae        | *Toddalia asiatica* (L.) Lam. | Tundpora    | WV Hook Climber | Medicinal    |
| Sapindaceae     | *Cardiospermum halicacabum* L. | Kanphura    | HV Tendril Climber | Medicinal   |
| Smilaceae       | *Smilax perfoliata* Lour.    | Mothuri     | HV Tendril Climber | Edible      |
|                 | *Smilax macrophylla* Roxb.   | Rajdantri   | HV Tendril Climber | Medicinal   |
| Vitaceae        | *Ampelocissus divaricata* (Wall. ex Lawson) Planch. | -           | WV Tendril Climber | -           |
|                 | *Ampelocissus latifolia* Planch. | Kanjinoi    | WV Tendril Climber | Medicinal   |
|                 | *Ampelocissus tomentosa* (B.Heyne & Roth) Planch. | Katobangonoi | WV Tendril Climber | Medicinal   |
|                 | *Cayratia pedata* (Lam.) Gagnep. | Pitapotala  | WV Tendril Climber | Medicinal   |
|                 | *Cissus adnata* Roxb.        | -           | WV Tendril Climber | Medicinal   |
|                 | *Cissus assamica* (Lawson) Craib. | -           | WV Tendril Climber | Medicinal   |
|                 | *Cissus quadrangularis* L.   | Hadasinkuda | WV Tendril Climber | Medicinal   |
|                 | *Cissus repens* Lam.         | Diboria     | WV Tendril Climber | Edible & Medicinal |

(WV: Woody vines; HV: Herbaceous Vines, PV: Parasitic Vines)
Figure 3. Photographs of some climbers in SBR, Odisha, India
Discussion

SBR is known for its unique ecological conditions, species richness and biodiversity. Climbers play an important role in the maintenance of several ecological processes in forest ecosystem. Although there are several observations and researches carried out in the area, still much more is remaining to be explored. During our survey out of climbing plants, 62 were lianas and other 58 were herbaceous climbers. The number is very less as compared to tropical evergreen forests of Peninsular India, Tropical forests of Northern Eastern Ghats of Andhra Pradesh and tropical forest of Southern Eastern Ghats of Tamilnadu in India which bears 148, 170, 175 species, respectively (Parthasarathy et al., 2004; Muthumperumal and Parthasarathy, 2009; Naidu et al., 2014). However, compared to few other forests in India, our numbers seem to be very high. Those are tropical forests of Coromandel coast of South India and tropical lowland evergreen forest of Agumbe in the central Western Ghats which have 39 and 40 number of species, respectively (Padaki and Parthasarathy, 2000; Reddy and Parthasarathy, 2003). Considering the species richness of different dry forests globally, the present value is much higher than several other forests. The liana species richness of the dry rain forest of New South Wales was 27 species in 21 ha area (Chalmers and Turner 1994). The tropical island sites of the West Indies harboured 3-14 liana species with an abundance of 6-34 in 0.1 ha area (Gentry 1991b). In the Central American Nicaraguan and Costa Rican dry forests, liana species richness was 16-24 in 0.1 ha area (Gillespie et al., 2000). The Mexican dry forest liana diversity, ranged from 8 to 22 species in 0.1 ha area. (Lott et al., 1987). Though the present study was not conducted within a particular area of SBR, it seems to be higher in species richness than the above discussed forests. Hence, the higher species richness of SBR indicates the importance of the forest in the country and globally.

Twinning habit of climbers is dominated in this study area followed by tendril habit. Twining habit of climbers is most common in tropical forests. Similar results were found in Malaysian forests (Putz and Chai, 1987). Disturbance usually leads to the proliferation of lianas (Wyatt-Smith, 1954; Webb, 1958; Putz, 1984; Putz and Chai, 1987). The present study revealed that due to rapid human interference, over exploitation of plant resources, habitat destruction and forest fires in the peripheral regions of SBR, many of the valuable climbing plants are coming towards extinction regionally and coming under threatened category. The invasion of weed species, *Mikania micrantha* is frequently observed during our study, which has negative impact on the diversity and supressing the host plant in many aspects. It is one of the 100 worst invasive alien species in the world (Lowe et al., 2001). Further, in some regions of SBR, such as Hatitop and Kachudhan, the dominance of climbers caused squeezing and compressing the host plant. Since, the climbers have significant impacts on the biodiversity. Hence, in such regions, the abundance of climbers must be checked for proper management of biological diversity. Therefore, sustainable use of forest biodiversity may be required especially in those forest zones where human utilization of the forest resources for different purposes is evident and inevitable.

Conclusions

The present study revealed that the climbing plants diversity of SBR not only contributing to the overall forest biodiversity significantly but also maintains the ecological balance of the whole ecosystem. However, the sites such as Hatitop, Kachudhan etc. the dominance of climbers have deleterious effects on the host plants. Many other tree species were suppressed and showing stunted growth due to the negative impact of these climbers. Therefore, management and sustainable use of climbers is required for which adequate knowledge of their diversity, biology and ecology is essential. Further research is required for better understanding of the dynamics and reproductive biology of climbing plants in order to recommend conservation strategies.
Authors’ Contributions

DR: Field work, data collection and manuscript writing; MRM: Field work and help in manuscript writing; SCS: Study design, field work and manuscript review. All authors read and approved the final manuscript.

Ethical approval (for researches involving animals or humans)

Not applicable.

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Conflict of Interests

The authors declare that there are no conflicts of interest related to this article.

References

Abbiw DK (1990). Useful plants of Ghana. Richmond Intermediate Technology Publications, Royal Botanic Gardens, KEW, London, pp 154-157.
Addo-Fordjour P, Anning AK, Larbi JA (2009a). Liana species richness, abundance and relationship with trees in the Bobiri forest reserve, Ghana: impact of management systems. Forest Ecology and Management 157:1822-1828. https://doi.org/10.1016/j.foreco.2009.01.051
Addo-Fordjour P, Obeng S, Addo MG (2009b). Effects of human disturbances and plant invasion on liana community structure and relationship with trees in the Tinte Bepo forest reserve, Ghana. Forest Ecology and Management 258:728-734. https://doi.org/10.1016/j.foreco.2009.05.010
Addo-Fordjour P, Rahmad ZB, Shahrul AMS (2012). Effects of human disturbance on liana community diversity and structure in a tropical rain forest, Malaysia: implication for conservation. Journal of Plant Ecology 4:391-399. https://doi.org/10.1093/JPE/RTS012
Arnold JEM, Ruiz Perez M (2001). Cannon-timber forest products match tropical forest conservation and development objectives? Ecological Economics 39:437-447.
Baars R, Kelly D, Sparrow AD (1998). Liana distribution within native forest remnants in two regions of the South Island, New Zealand. New Zealand Journal of Ecology 22:71-85.
Behera KK (2006). Ethnomedicinal plants used by tribes in Similipal Biosphere Reserve, Orissa, India: A pilot study. Ethnomedicinal Leaflets 10:149-173.
Bonger F, Schnitzer SA, Traore D (2002). The importance of lianas and consequences for forest management in West Africa. Bio Terre, Special edition, pp 59-70.
Bullock SH (1995). Breeding systems in the flora of a tropical deciduous forest in Mexico. Biortropica 17:287-301. https://doi.org/10.2307/2388591
Cai ZQ, Schnitzer SA, Bongers F (2009). Liana communities in three tropical forest types in Xishuangbanna, South-West China. Journal of Tropical Forest Science 21:252-264. http://myais.fsktm.um.edu.my/8548/
Chalmers AC, Turner JC (1994). Climbing plants in relation to their supports in a stand of dry rainforest in the Hunter Valley, New South Wales. Proceedings of the Linnean Society of New South Wales 114:73-90.

Dalling JW, Schnitzer SA, Baldeck C, Harms KE, John R, Mangan SA, ... Hubbell SP (2012). Resource-based habitat associations in a neotropical liana community. Journal of Ecology 100:1174-1182.

Dash M, Behera B (2013). Biodiversity conservation and local livelihoods: A study on Simulipal Biosphere Reserve in India. Journal of Rural Development 32(4):409-426.

DeWalt SJ, Schnitzer SA, Chave J, Bongers F, Burnham RJ, Cai Z, Thomas D (2010). Annual rainfall and seasonality predict pan-tropical patterns of liana density and basal area. Biotropica 42:309-317. https://doi.org/10.1111/j.1744-7429.2009.00589.x

Gamble JS, Fischer CEC (1915-1935). Flora of Presidency of Madras; Vol: I-III. Adlard and Son Ltd, London, UK.

Gentry AH (1991a). The distribution and evolution of climbing plants. In: Putz FE, Mooney HA (Eds). The Biology of Vines. Cambridge University Press, Cambridge, pp 3-49.

Gentry AH (1991b). Breeding and dispersal systems of lianas. Cambridge University Press, pp 393-426.

Gianoli E, Saldana A, Jimenez-Castillo M (2010). Distribution and abundance of vines along the light gradient in a southern temperate rain forest. Journal of Vegetation Science 21:66-73. https://doi.org/10.1111/j.1654-1103.2009.01124.x

Gillespie TW, Grijalva A, Farris CN (2000). Diversity, composition and structure of tropical dry forest in Central America. Plant Ecology 147:37-47. https://doi.org/10.1023/A:1009848525399

Haines HH (1921-1925). The Botany of Bihar & Orissa; Vol: I-VI. London. Rep. ed. BSI, Calcutta.

Ibarra-Manriquez G, Martinez-Ramos M (2002). Landscape variation of liana communities in a Neotropical rain forest. Plant Ecology 160:91-112. https://doi.org/10.1023/A:1015839400578

IIRS (2002). Biodiversity Characterization at Landscape Level in North East India Using Satellite Remote Sensing and Geographic Information System. Indian Institute of Remote Sensing (IIRS), Dehradun.

Lott EJ, Bullock SH, Solis-Magallanes AJ (1987). Floristic diversity and structure of upland and arroyo forest of coastal Jalisco. Biotropica 19:228-235. https://doi.org/10.2307/2388340

Lowe S, Browne M, Boudjelas S, De Poorter M (2001). 100 of the World’s Worst Invasive Alien Species: A selection from the Global Invasive Species Database. The Invasive Species Specialist Group (ISSG) pp 12.

Maria MGL, Laura MI, Felipe NAM, Jennifer SP, Stefan AS (2017). Lianas reduce community-level canopy tree reproduction in a Panamanian forest, Journal of Ecology 106(2):737-745. https://doi.org/10.1111/1365-2745.12807

Mishra RK, Upadhyay VP, Mohanty RC (2008). Vegetation ecology of Simulipal Biosphere Reserve, Orissa, India. Applied Ecology and Environmental Research 6(2):89-99.

Misra S (2004). Orchids of Odisha. Bishen Singh and Mahendra Pal Singh Publications, Dehradun, pp 1-424.

Muthumperumal C, Parthasarathy N (2009). Angiosperm, Climbing plants in tropical forests of Southern Eastern Ghats, Tamil Nadu, India. Checkflora 5(1):092-111. https://doi.org/10.15560/5.1.92

Naidu MT, Kumar OA, Venkiah M (2014). Taxonomic diversity of Lianas in Tropical forests of Northern Eastern Ghats of Andhra Pradesh, India. Norulae Scientia Biologicae 6(1):59-65. https://doi.org/10.15835/nisb19193

Padaki A, Parthasarathy N (2000). Abundance & distribution of lianas in tropical low land evergreen forest of Agumbe, Central Western, India. Tropical Ecology 41(2):143-154.

Panda SK (2014), Ethnomedicinal uses and screening of plants for antibacterial activity from Simulipal Biosphere Reserve, Odisha, India. Journal of Ethnopharmacology 151:158-175. https://doi.org/10.1016/j.jep.2013.10.004

Parthasarathy N, Muthuramkumar S, Reddy MS (2004). The pattern of Liana diversity in tropical evergreen forests of Peninsular India. Forest Ecology and Management 190:15-31. https://doi.org/10.1016/j.foreco.2003.10.003

Poulsen AD, Hafashimana D, Eilu G (2005). Composition and species richness of forest plants along the Albertine Rift, Africa. Biologiske Skrifter 55:129-143.

Putz FE (1984). The natural history of Lianas on Barro Colorado Island, Panama. Ecology 65:1713-1724. https://doi.org/10.2307/1937767

Putz FE, Chai P (1987). Ecological studies of lianas in Lambir National Park, Sarawak. Journal of Ecology 75:523-531. https://doi.org/10.2307/2260431

Putz FE, Mooney HA (1991). The biology of vines. Cambridge: Cambridge University Press.

Reddy MS, Parthasarathy N (2003). Liana diversity and distribution in four tropical dry evergreen forests on the Coromandel coast of South India. Biodiversity and Conservation 12:1609-1627. https://doi.org/10.1023/A:1023620901624
Saxena HO, Brahman M (1989). The flora of Similipal with special reference to the potential economic plants. Regional Research Laboratory, Bhubaneswar.

Saxena HO, Brahman M (1994-1996). The flora of Odisha; Vol: I-IV. Orissa Forest Department Corporation Ltd, Bhubaneswar.

Schnitzer SA, Bongers F (2002). The ecology of lianas and their role in forests. Trends in Ecology and Evolution 17:223-230. https://doi.org/10.1016/S0169-5347(02)02491-6

Schnitzer SA, Kuzee ME, Bongers F (2005). Disentangling above- and below-ground competition between lianas and trees in a tropical forest. Journal of Ecology 93:1115-1125. https://doi.org/10.1111/j.1365-2745.2005.01056.x

Toledo M (2010). Neotropical lowland forests along environmental gradients. Ph.D. Thesis, Wageningen University.

Van Andel T (2000). Non-timber forest products of the north-West District of Guyana. Tropenbos Guyana Series 8a, Tropenbos Foundation, Wageningen.

Ved DK, Kinhal GA, Ravikumar K, Vijaysankar R, Sumathi R, Mahapatra AK, Panda PC (2007). CAMP Report: Conservation assessment and management prioritisation for medicinal plants of Orissa, India. Foundation for revitalization of local health traditions, Bangalore.

Webb LJ (1958). Cyclones as an ecological factor in tropical lowland rainforest, North Queensland. Australian Journal of Botany 6:220-228. https://doi.org/10.1071/BT9580220.

Wyatt-Smith J (1954). Storm forest in Kelantan. Malayan Forester 17:5-11.