Grass Flora along Altitudinal Gradient of the Phulchoki Hill, Central Nepal

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Abstract

Phulchoki hill on the southern part of Kathmandu Valley (1550-2750 m) presents a unique opportunityto study the diversity of grasses along the altitudinal gradient. During the present study, 73 species ofgrasses belonging to 5 sub families, 16 tribes and 48 genera were recorded, out of which 28 species are new to this area. Among the recorded species 89% of the species were terrestrial, 7% lithophytesand remaining 4% aquatic. The lowest elevation (1550-1950 m) has highest diversity with 49 species whereas the topmost band (2351-2750 m) has least diversity with only 19 species. The total species richness of grass has decreasing trend along the altitudinal gradient of species, with r^2 =0.97 and p=0.04, which indicates significant relation.

Keywords: Altitude, Habitat, Species richness

Introduction

Poaceae Barnhart, is nearly ubiquitous family of flowering plants known as grasses (Anderton & Barkworth, 2009). It is the fifth largest familyof flowering plants in the world (Angiosperm Phylogeny Group [APG], 2016; Bouchenak- Khelladi et al., 2010). There are 11,506 grass speciesbelonging to 768 genera, 12 subfamilies, 52 tribes and 90 sub tribes reported (Soreng et al., 2017) based on the recent molecular data, worldwide phylogenetic classification of the grasses. According to the recent publication, Nepal includes 426 speciesin grass family (Shrestha et al., 2022).

Only 24 species of grasses were reported in the Floraof Phulchoki and Godawari (Suwal, 1969). Later, Malla et al. (1974) reported one additional species ofgrass for Flora of Phulchoki and Godawari. While,Malla et al. (1986) recorded 28 species of grasses that were collected from Phulchoki and Godawari area in the Flora of Kathmandu Valley. However, Suwal (1997) and Rajbhandari & Baral (2010) listed only 24 species of grasses collected from Godawariand Phulchoki. Therefore, the main objective of this paper is to highlight an overview on grasses ofGodawari-Phulchoki forest, which is also expectedto contribute for the Flora of Nepal documentation.

Materials and Methods

Study Area

Phulchoki, also known as Fulchok, Phulchoki Dada,and Phulchoki hill is the most prominent peak at an elevation of 2.757m (Figure 1) above the sea level,located in Lalitpur district of Bagmati zone. It lies in the southern part of Kathmandu valley between 28.2785ºN latitude and 84.3073ºE longitude in a transition zone between subtropical and temperate climate (Suwal, 1997). Phulchoki is an important area which harbours diverse flora and fauna withina small geographical area (Gaire, 2009). It covers anarea of approximately 50 sq. km consisting of a vast range of Flora (Suwal, 1997). The natural vegetation of Phulchoki hill is characterized into three distinctforest types: mixed *Schima-Castanopsis* forest at thebase (1400-1800 m), Oak-Laurel forest (1800-2400m) in the middle and evergreen oak forests (2000 mabove) towards the top (Poudyal et al., 2012).

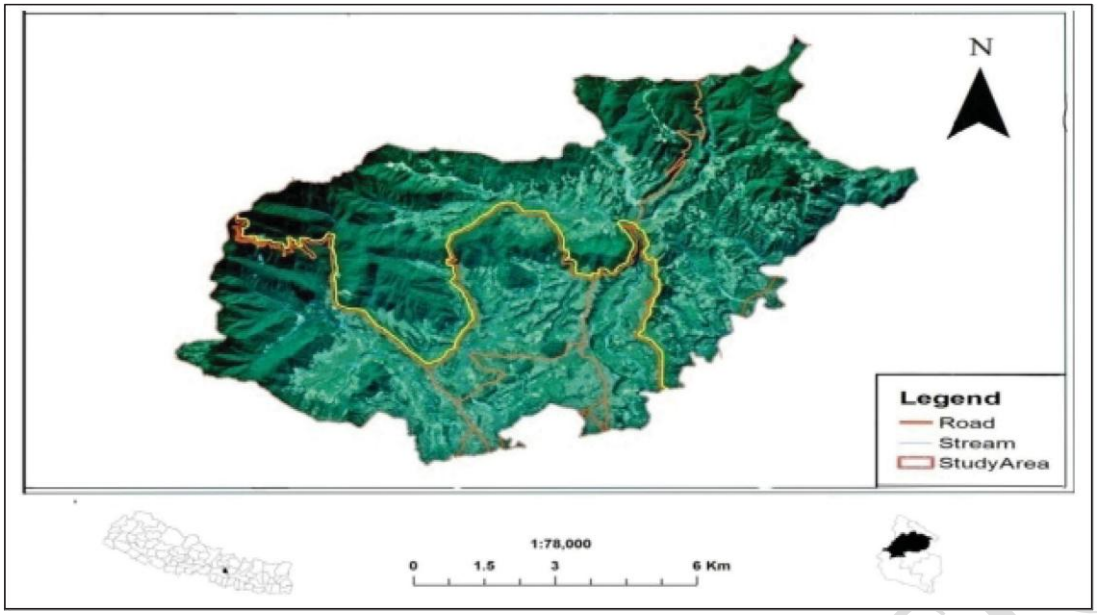

Figure 1: Location map of study area, Godawari and Phulchoki

Field visits, collection and identification of grasses

Intensive survey of the study area was undertaken in different seasons, from May 2017 - January 2018 to collect grasses from their natural habitat.

During the field visits, numerous close-up photographs was taken of grasses found in the area before the collection (Figure 7, 8 and 9). For the collection of plant specimens, the whole plant was pulled out along with their rhizomatous root or by using the digger. At the time of the collection, notes were taken with information about the soil type, surrounding vegetation, altitude and other important details.

Large grass specimens were then cut into required size without losing any important characteristic features. All collected specimen were pressed in the blotting paper or newspaper with some larger specimen folded in N or V shape. Corrugated sheet was kept between the newspaper of every specimens for quick drying. Delicate spikelet was collected in tissue paper. Newspapers used for the pressing of plant specimens were changed daily until the plants were properly dry. Standard technique was followed for the collection and preparation of specimens (Siwakoti & Rajbhandary, 2015). The dried specimens were finally mounted on herbarium sheets having standard size (i.e. 45 cm length and 30 cm wide), labelled with field note and deposited at Tribhuvan University Central Herbarium (TUCH).

Identification of species were done with the help of specimens in the herbarium of National Herbarium and Plant Laboratories, Godawari (KATH) and Tribhuvan University Central herbarium, Kathmandu (TUCH), Flora of Phulchoki and Godawari, Flora of Kathmandu Valley, Flora of China, Flora of Bhutan, Catalogue of Nepalese Flowering Plants and Handbook of Flowering plants. The identified specimens were rechecked through expert determination. All species were classified according to Grass Phylogeny Working Group (GPWG II, 2012) and Angiosperm Phylogeny Group (APG IV, 2016).

Sampling was carried out in Phulchoki hill starting from elevation 1550-2750 m in northern aspects at the difference of 200 m. Stratified random sampling method was used for data collection (Kershaw & Looney 1985). The forest area was horizontally divided into six bands, at each elevation band of 200 m, six quadrats were laid down with the difference of 100 m apart. All the species of grasses were noted from each plot. The variation of species distribution along the altitudinal gradient was compared. Species distribution,

composition and diversity of grasses were analyzed by using appropriate statistical tools(Microsoft Excel 2007 and R core Team 2017). Species richness was related to the temporal gradientby means of Generalised Linear Model (GLM)(McCullagh & Nelder 1989; Nelder & Wedderburm1972).

Results and Discussion

Total number of species under different rank

The present study recorded rich diversity of grasses(Appendix 1) from Phulchoki hill which belonged to 5 subfamilies, 16 tribes, 48 genera and 73 species. The recorded 73 species belonged to different subfamilies like Ehrhartoideae (1 sp.), Pooideae (16 spp.), Arundinoideae (2 spp.), Chloridoideae (9 spp.) and Panicoideae (45 spp.) (Figure 2).

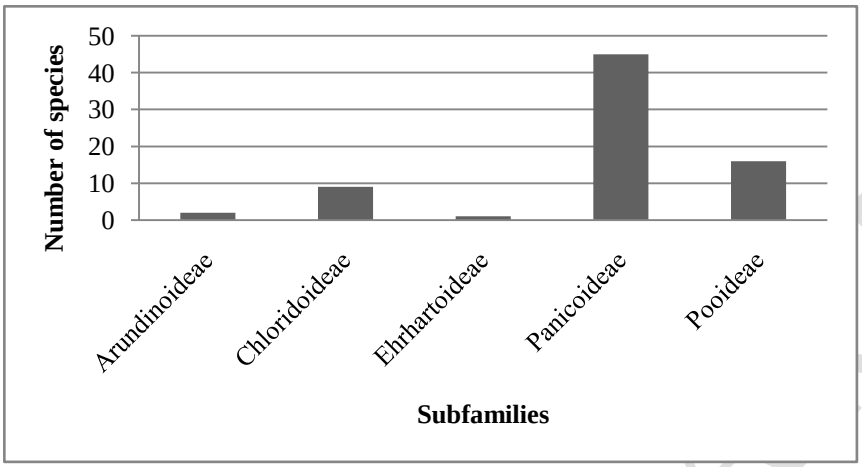

Figure 2: Number of species in each subfamily

The result shows high diversity of tribe Paniceae with 22 species of subfamily Panicoideae, which was followed by the tribe Andropogoneae with 16 speciesof the same subfamily Panicoideae (Figure 3).

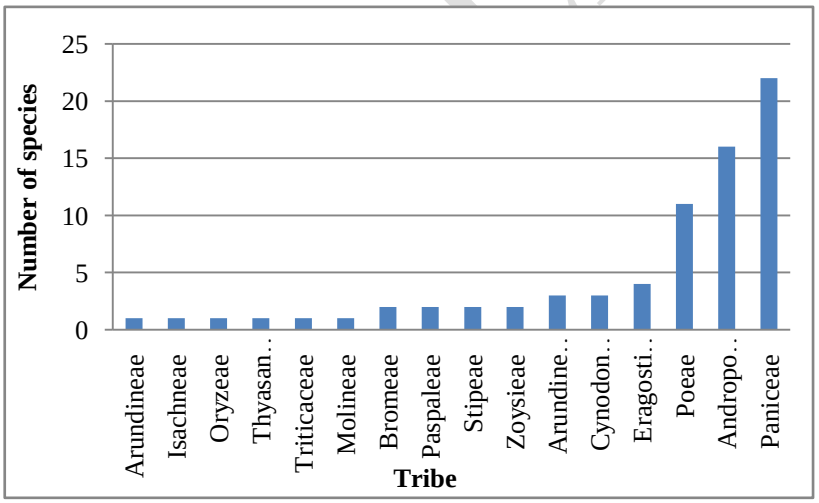

Figure 3: Number of species in each tribe

Among the 49 genera, *Eragrostis* Wolf, *Setaria* P.Beauvois and *Digitaria* Haller were the largest generawith four species each followed by *Oplismenus* P. Beauvois and *Microstegium* Nees with three species each. Other genera like *Sporobolus* R. Brown, *Arundinella* Raddi., *Saccharum* Linn., *Polypogon* Desf., *Bromus* Linn, *Chrysopogon* Trin., *Paspalum*Linn., *Echinochloa* P. Beauvois, *Agrostis* Linn. and*Brachiaria* (Trinn.) Grisebach were represented bytwo species each and rest of the others genera withone species each.

Distribution of species among various habitats

Out of 73 species of grasses, 89% species were foundto be terrestrial, 7% were found to be lithophytes and remaining 4% were aquatic. Some of the species were found growing in two habitat i.e. terrestrial and lithophytes or terrestrial and aquatic (Figure 4). *Tripogon filiformis* Nees ex Steud., *Arthraxon lancifolius* (Trin.) Hochst, *Eragrostis pastoensis* (Kunth) Trin. and *Digitaria longiflora* (Retz.) Pers.were found growing only on rocks (completelylithophytes) and *Coix lacryma-jobi* L., *Paspalum distichum* L. and *Leersia hexandra* Sw. were foundgrowing only in water (completely aquatic). Four species *Digitaria ciliaris* (Retz.) Koel., *Saccharum rufipilum* Steud, *Capillipedium assimile* (Steud) A. Camus and *Microstegium petiolare* Trin were found growing in both habitat i.e. terrestrial and lithophytes and three *species Poa annua* L., *Cyrtococcum patens* (L.) A. Camus, *Polypogon monspeliensis* (L.) Desf. grew in terrestrial as well as aquatic habitat. Rest of the species were found growing along the roadside in the terrestrial form (Figure 3). Usually grasses areabundant in an open canopy area where access of sunlight is maximum and lesser amount of organic nutrients are present (Kumar, 2014; Rahbek, 1997). Canopy is significant factor which influence the light intensity reaching the ground (Panthi et al., 2007; Sharma et al., 2016; Vetaas, 1997). Forest in Phulchoki hill is very dense with high tree canopy cover, which might be one of the possible reasons forlesser distribution of grasses inside the core forest.

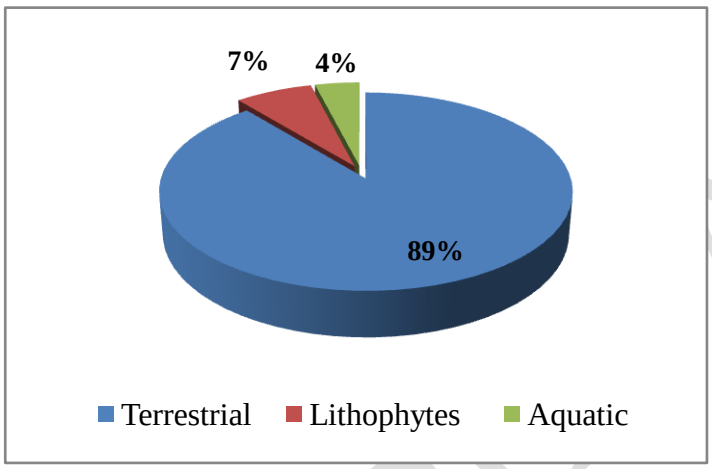

Figure 4: Percentage of species in different habitat

Distribution of species along the altitudinal gradient

In the present study, the elevation ranges from 1550-1950 m. out of 73 grass species, the lowest elevation i.e. 1550-1950 m showed highest diversity which included 49 species, whereas the topmost band 2351-2750 m showed least diversity withonly 19 species. The middle band i.e. 1951-2350 showed moderate count of 34 species (Figure 5). This study clearly indicated that the distribution and diversity of grasses was highest at the elevationranges 1500-1600 m, probably because this area contains favorable climatic condition for grasses like temperature, precipitation, soil parameters etc.But the grass diversity was least at the altitude rangefrom 1700-2200 m which consists of a very moist area with dense forest and thick tree canopy. The diversity of grass species richness showed decreasingtrends along the altitudinal gradient. Grass specieswere in declining pattern along the elevation with r^2 =0.977~ 1. The value of r^2 ~1, showed significant relation. Moreover, p value was 0.041 ($p<0.05$) which is statistically significant (Figure 6). General concept about the decrease in species richness withthe gradual increase in altitude (Baniya et al., 2010;Brown & Lomolino, 1998; Fossa, 2004; Korner, 2000) has been justified with the study.

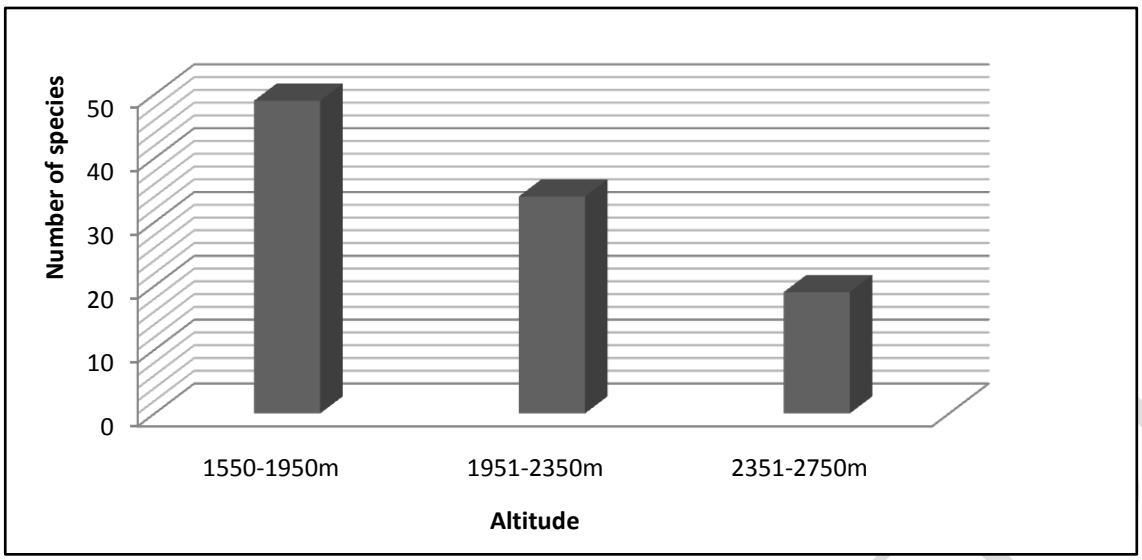

Figure 5: Number of species along the altitudinal range (based on herbarium collection)

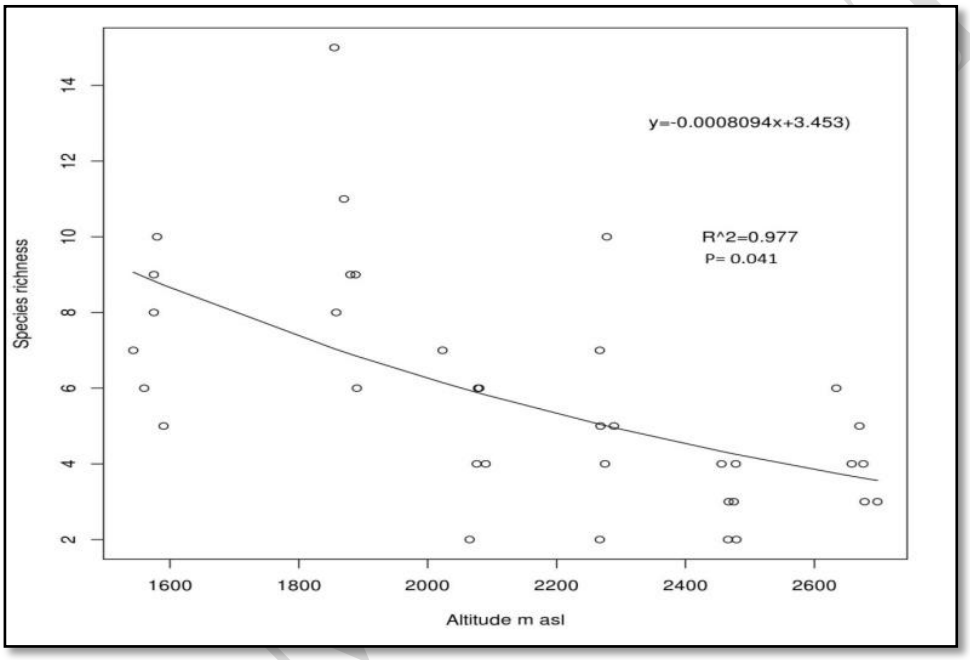

Figure 6: Relationship between variations of total species richness along elevation. The fitted line represented the GLM first order at significant level $p \leq 0.05$

Floristic composition

There is no uniformity in the record of grasses found in Phulchoki hill under different publications. The Department of Plant Resources published Flora of Phulchoki and Godawari (1969) which enlisted 24 species of grasses. Later in 1974, Malla et al., reported 1 additional species of grass for Flora of Phulchoki and Godawari. But Suwal (1997) listed only 24 species of grasses as a revised version to the old record of 1969 and additional one species [*Imperata cylindrica* (L.) Rausch.] reported by Malla et al. (1974) was not included. While, Flora of Kathmandu Valley included 28 species of grasses collected from the study area and Catalogue of Nepalese Flowering Plant (2010) enlisted only 21 species of grasses. In Tribhuvan University Herbarium (TUCH), only 6 specimens (*Arundinella nepalensis* Trin., *Eragrostis amabilis* (L.) Kuntze, *Polypogon monspeliensis* (L.) Desf., *Pennisetum*

purpureum Schumach., *Mischanthus nepalensis* (Trin.) Hack. and *Saccharum rufipilum* (Steud.) are recorded from the study area. However, from the present study, 73 species of grasses have been documented, which is about three times higher thanthe previous record (Appendix 1). Out of 73 species, 28 species of grasses are found to be new for this area as they have not yet been listed in any of the previous publication regarding the Flora of Phulchoki and Godawari.

The 28 newly recorded species are *Arundinella setose* Trin., *Arundo donax* L., *Avena fatua* L., *Axonopus compressus* (Sw.) P.Beauv., *Bothriochloa pertusa* (L.) A. Camus, *Brachiaria ramosa* (L.) Stapf., *Brachiaria villosa* (Lam.) A. Camus, *Bromus catharticus* Vahl., *Bromus himalaicus* Stapf., *Chrysopogon fulvus* (Spreng.) Chiov., *Coix lacryma-jobi* L., *Digitaria longiflora* (Retz.) Pers., *Digitaria radicosa* (J. Presl) Miq., *Digitaria stricta* Roth. ex Roem. & Schult., *Eleusine indica* (L.) Gaertn., *Eragrostis pilosa* (L.) P.Beauv., *Garnotia tenella* (Arn. ex Miq.) Janowski, *Microstegium ciliatum* (Trin) A. Camus, *Microstegium nudum* (Trin) A. Camus, *Oplismenus undulatifolius* (Ard.) P.Beauv., *Piptatherum laterale* (Regel) Nevski., *Panicum humile* Nees ex Steud., *Panicum sumatrense* Trin., *Pseudoechinolaena polystachya* (Kunth) Stapf., *Saccharum spontaneum* L., *Setaria intermedia* Roemer & Schultes, *Sporobolus diandrus* (Retz.) P.Beauv. and *Stipa roylei* (Nees) Duthie.

Conclusion

A total number of 73 species of grasses belonging to 5 sub families, 16 tribes and 48 genera has been documented from the present study. Among the documented species, 28 species of grasses were found to be new for this area. This shows that grass diversity was not explored properly in the past. On the basis of habitat, out of 73 species of grass, 89% species were found to be terrestrial, 7% were found to be lithophytes and remaining 4% were aquatic. Out of 73 species, the lowest elevation i.e. 1550-1950 m showed highest diversity, with 49 species whereas the topmost band 2351-2750 m showed least diversity with 19 species. The diversity of grass species showed decreasing trend along the altitudinal gradient, with r^2 =0.97 and p=0.04 value, which showed high statistical significance between the two variables.

Author Contributions

Both the authors have contributed equally to bring the manuscript in this form.

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Appendix 1: List of grasses collected from Godawari to Phulchoki

Code No.	Scientific name	Altitude (m)	Latitude (°)	Longitude (°)	Habitat	Location	Date of collection
GP 51	*Agrostis micrantha* Steud.	1967	27.344	85.231	Terrestrial	Phulchoki	9th Sep, 2017
GP 34	*Agrostis pilosula* Trin.	2021	27.345	85.232	Terrestrial	Phulchoki	5th Sep, 2017
GP 21	*Arthraxon lancifolius* (Trin.) Hochst	1598	27.324	85.35	Lithophyte	Naudhara	2nd Oct, 2017
GP 18	*Arundinella nepalensis* Trin.	1560-2300	27.345	85.224	Terrestrial	Godawari-Phulchoki	31stAug, 2017
GP 34	*Arundinella setosa* Trin.	2700	27.343	85.235	Terrestrial	Phulchoki	5th Sep, 2017
GP 29	*Arundo donax* L.	2369	27.344	85.234	Terrestrial	Phulchoki	2nd Oct, 2017
GP 42	*Avena fatua* L.	1659	27.344	85.224	Terrestrial	Godawari	9th Sep, 2017
GP 38	*Axonopus compressus* (Sw.) P. Beauv.	1550	27.432	85.382	Lithophyte	Godawari	31stSep, 2017
GP 07	*Bothriochloa pertusa* (L.) A. Camus	1560	27.432	85.321	Terrestrial	Naudhara	1st Aug, 2017
GP 61	*Brachiaria ramosa* (L.) Stapf.	1575	27.356	85.333	Lithophytes	Naudhara	31stAug, 2017
GP 60	*Brachiaria villosa* (Lam.) A. Camus	1575	27.356	85.333	Terrestrial	Naudhara	31stAug, 2017
GP 08	*Bromus catharticus* Vahl.	1550	27.432	85.382	Terrestrial	Godawari	27thMay,2017
GP 72	*Bromus himalaicus* Stapf.	2560	27.342	85.235	Terrestrial	Phulchoki	9th Sep, 2017
GP O4	*Calamogrostis emodensis* Griseb.	1909	27.344	85.23	Terrestrial	Phulchoki	27thMay,2017
GP 10	*Capillipedium assimile* (Steud.) A. Camus.	2200	27.344	85.234	Terrestrial	Phulchoki	9th Sep, 2017
GP 44	*Chrysopogon aciculatus* (Retzius) Trin.	1560	27.432	85.382	Terrestrial	Godawari	31stSep, 2017
GP 33	*Chrysopogon fulvus* (Spreng.) Chiov.	1560	27.432	85.382	Terrestrial	Godawari	31stSep, 2017
GP 90	*Coix lacryma-jobi* L.	1550	27.432	85.382	Aquatic	Godawari	27th Jan, 2018
GP O3	*Cynodon dactylon* (L.) Pers.	1550	27.432	85.382	Terrestrial	Godawari	31stAug, 2017
GP 54	*Cyrtococcum patens* (L.) A. Camus	1560	27.432	85.382	Terrestrial & Aquatic	Godawari	31stSep, 2017
GP 67	*Digitaria ciliaris* (Retz.) Koel.	1500	27.432	85.382	Terrestrial	Godawari	31stSep, 2017
GP 75	Digitaria longiflora (Retz.) Pers.	1985	27.345	85.231	Lithophytes	Phulchoki	27thMay,2017
GP 71	*Digitaria radicosa* (J. Presl) Miq.	2496	27.343	85.235	Terrestrial	Phulchoki	9th Sep, 2017
GP 63	*Digitaria stricta* Roth. ex Roem. & Schult.	1575	27.432	85.367	Lithophyte	Godawari	31stAug, 2017
GP 09	*Echinochloa colona* (L.) Link.	1634	27.345	85.224	Terrestrial	Phulchoki	31stSep, 2017
GP 67	*Echinochloa crusgalli* (L.) P. Beauv.	1550	27.432	85.382	Terrestrial	Godawari	5th Sep, 2017
GP 16	*Eleusine indica* (L.) Gaertn.	1550-1600	27.35	85.224	Terrestrial	Godawari	31stAug, 2017
GP 70	*Elymus semicostatus* (Nees ex Steud.) Melderis	2552	27.436	85.342	Terrestrial	Phulchoki	27th May, 2017
GP 49	*Eragrostis pastoensis* (Kunth) Trin.	1598	27.345	85.382	Lithophyte	Naudhara	31stAug, 2017
GP 15	*Eragrostis atrovirens* (Desf.) Trin. ex. Steud.	1550	27.432	85.382	Lithophytes	Godawari	27th Jan, 2018
GP 40	*Eragrostis nigra* Nees ex Steud.	1550-2700	27.467	85.367	Terrestrial	Godawari-Phulchoki	27thAug, 2017

Code No.	Scientific name	Altitude (m)	Latitude (°)	Longitude (°)	Habitat	Location	Date of collection
GP 50	*Eragrostis pilosa* (L.) P. Beauv.	1550	27.432	85.382	Terrestrial	Godawari	31st Aug, 2017
GP 23	*Eulalia molis* (Griseb.) Kuntze	1985-2700	27.345	85.231	Terrestrial	Godawari-Phulchoki	31st Sep, 2017
GP 06	*Festuca leptopogon* Stapf.	1852	27.345	85.225	Terrestrial	Phulchoki	27th May,2017
GP 52	*Garnotia tenella* (Arn. ex Miq.) Janowski	2021	27.345	85.232	Lithophyte	Phulchoki	5th Sep, 2017
GP 62	*Helictotrichon junghuhnni* (Buse) Henrard	2039	27.345	85.231	Terrestrial	Phulchoki	5th Sep, 2017
GP 43	*Imperata cylindrica* (L.) Rausch.	2023	27.345	85.232	Terrestrial /Lithophyte	Phulchoki	31st Aug, 2017
GP 22	*Iscahne albens* Trin.	1743	27.343	85.224	Terrestrial	Naudhara	2nd Sep, 2017
GP 11	*Leersia hexandra* Sw.	1550	27.432	85.382	Aquatic	Godawari	9th Sep, 2017
GP 74	*Lolium perenne* L.	2750	27.341	85.242	Lithophyte	Phulchoki	2nd Oct,2017
GP 28	*Microstegium ciliatum* (Trin) A. Camus	1743	27.343	85.224	Terrestrial	Phulchoki	2nd Sep, 2017
GP 68	*Microstegium nudum* (Trin) A. Camus	1870	27.344	85.231	Terrestrial	Phulchoki	2nd Sep, 2017
GP 46	*Microstegium petiolare* Trin.	1870-2400	27.344	85.233	Terrestrial	Godawari-Phulchoki	2nd Sep, 2017
GP 26	*Mischanthus nepalensis* (Trin.) Hack.	2115	27.344	85.234	Terrestrial/ Lithophyte	Phulchoki	5th Sep, 2017
GP O1	*Oplismenus burmanni* (Retz.) P. Beauv.	1550	27.432	85.382	Terrestrial/ Lithophyte	Godawari	2nd Sep, 2017
GP 45	*Oplismenus compositus* (L.) P. Beauv.	1676	27.344	85.224	Terrestrial	Phulchoki	27th May, 2017
GP 6	*Oplismenus undulatifolius* (Ard.) P. Beauv.	1569	27.345	85.382	Terrestrial	Naudhara	31st Aug, 2017
GP 41	*Panicum humile* Nees ex Steud.	1550	27.432	85.382	Terrestrial	Godawari	31st Sep, 2017
GP 13	*Panicum sumatrense* Trin.	1550	27.432	85.382	Terrestrial	Godawari	31st Sep, 2017
GP 14	*Paspalum distichum* L.	1550	27.432	85.382	Terrestrial & Aquatic	Godawari	1st Aug, 2017
GP 02	*Paspalum scrobiculatum* L.	2023	27.345	85.232	Terrestrial	Phulchoki	1st Aug, 2017
GP 47	*Pennisetum purpureum* Schumach.	1550	27.432	85.382	Terrestrial	Godawari	2nd Sep, 2017
GP 80	*Piptatherum laterale* (Regel) Nevski.	2350	27.348	85.356	Terrestrial	Godawari-Phulchoki	2nd Oct, 2017
GP 20	*Phalaris minor* Retz.	1985	27.345	85.231	Terrestrial	Phulchoki	9th Sep, 2017
GP 35	*Phragmites karka* (Retz.) Trin. ex Steud.	2496	27.343	85.235	Terrestrial	Phulchoki	2nd Sep, 2017
GP 25	*Poa annua* L.	1500-2100	27.432	85.235	Terrestrial & Aquatic	Godawari-Phulchoki	27th May, 2017
GP 31	*Pogonantherum crinitum* (Thunb.) Kunth	2370	27.344	85.234	Terrestrial	Phulchoki	27th May, 2017
GP 53	*Polypogon fugax* Nees ex Steud.	1500	27.432	85.382	Terrestrial	Godawari	27th May, 2017
GP 11	*Polypogon monspeliensis* (L.) Desf.	2548	27.342	85.242	Terrestrial & Aquatic	Phulchoki	1st Aug, 2017
GP 65	*Pseudoechinolaena polystachya* (Kunth) Stapf.	1600	27.356	85.382	Terrestrial	Naudhara	31st Aug, 2017

Code No.	Scientific name	Altitude (m)	Latitude (°)	Longitude (°)	Habitat	Location	Date of collection
GP 68	*Saccharum rufipilum* Steud.	2370	27.342	85.234	Terrestrial/ Lithophyte	Phulchoki	5th Sep, 2017
GP 24	*Saccharum spontaneum* L.	1500	27.234	85.382	Terrestrial	Godawari	5th Sep, 2017
GP 19	*Sacciolepis indica* (L.) Chase	1550-2200	27.234	85.345	Terrestrial	Godawari-Phulchoki	9th Sep, 2017
GP 36	*Setaria intermedia* Roemer & Schultes	1550	27.432	85.382	Terrestrial	Godawari	2nd Sep, 2017
GP 89	*Setaria palmifolia* (J. Konig) Stapf	2081	27.344	85.233	Terrestrial	Phulchoki	27th Jan, 2017
GP 12	*Setaria parviflora* (Poir.) Kerg.	2115	27.344	85.232	Terrestrial	Phulchoki	2nd Sep, 2017
GP 48	*Setaria plicata* (Lam.) T. Cooke.	2115	27.344	85.232	Terrestrial	Phulchoki	2nd Sep, 2017
GP 27	*Sporobolus diandrus* (Retz.) P. Beauv.	2370	27.344	85.234	Terrestrial	Phulchoki	2nd Oct,2017
GP 31	*Sporobolus fertilis* (Steud.) Clayton	2200	27.344	85.234	Terrestrial	Phulchoki	1st Aug, 2017
GP 86	*Stipa royeli* (Nees) Duthie	2589	27.346	85.345	Terrestrial	Phulchoki	1st Aug, 2017
GP 73	*Themeda hookeri* (Poir.) A. Camus	2560	27.342	85.235	Terrestrial	Phulchoki	9th Sep, 2017
GP 37	*Thysanolaena latifolia* (Roxb. ex Hornem.) Honda	2370	27.344	85.234	Terrestrial	Phulchoki	5th Sep, 2017
GP 30	*Tripogon filiformis* Nees ex Steud.	1550-2750	27.234	85.333	Lithophyte	Godawari-Phulchoki	5th Sep, 2017

Figure 7 : A. *Polypogon monspeleinsis* (Kharbuja et al., 2017 GP 11), **B.** *Cynodon dactylon* (Kharbuja et al., 2017 GP 03), **C.** *Pogonantherum crinitum* (Kharbuja et al., 2017 GP 31), **D.** *Saccharum spontaneum* (Kharbuja et al., 2017 GP 24), **E.** *Microstegium ciliatum* (Kharbuja et al., 2017 GP 28), **F.** *Saccharum rifipilum* (Kharbuja et al., 2017 GP 87), **G.** *Bothriochloa assimilis* (Kharbuja et al., 2017 GP 10), **H.** *Arundinella nepalensis* (Kharbuja et al. , 2017), GP 18) , **I.** *Poa annua* (Kharbuja et al., 2017 GP 25)

Figure 8: **A.** *Oplismenus brumanni* (Kharbuja et al., 2017 GP 01), **B.** *Festuca leptopogon* (Kharbuja et al., 2017 GP 06), **C.** *Calamogrostis emodensis* (Kharbuja et al., 2017 GP 04), **D.** *Bothriochloa pertusa*, (Kharbuja et al., 2017 GP 07), **E.** *Avena fatua* (Kharbuja et al., 2017 GP 42), **F.** *Bromus catharticus* (Kharbuja et al., 2017 GP 08), **H.** *Coix lachryma-jobi* (Kharbuja et al., 2017 GP 90), **I.** *Helictotrichon junghuhnni* (Kharbuja et al., 2017 GP 62)

Figure 9: **A.** *Paspalum distichum* (Kharbuja et al., 2017 GP 14), **B.** *Sacciolepis indica*, (Kharbuja et al., 2017 GP 19), **C.** *Microstegium ciliatum (*Kharbuja et al., 2017 GP 28), **D.** *Setaria intermedia* (Kharbuja et al., 2017 GP 36) , **E.** *Setaria parviflora* (Kharbuja et al., 2017 GP12), **F.** *Echinochloa colona* (Kharbuja et al., 2017 GP 09), **G.** *Oplismenus compositus* (Kharbuja et al., 2017 GP 45), **H.** *Paspalum scrobiculatum* (Kharbuja et al., 2017 GP 02), **I.** *Impereta cylindrica* (Kharbuja et al., 2017 GP 43).