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Floristic composition and plant species diversity in and around the brickfield areas of Savar-Dhamrai region of Dhaka district

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Abstract

This study has confirmed the occurrence of a total of 181 species of vascular plants under 133 genera and 51 families and estimates the plant species diversity in and around the brickfield areas of Savar-Dhamrai region of Dhaka district. Of these, six species were pteridophytes, 175 were Angiosperms, and 144 species were economically important. Five families, composed of six species, belonged to Pteridophyta, 40 families, consist of 128 species, to Magnoliopsida (dicotyledons) and six families, comprised of 47 species, to Liliopsida (monocotyledons). Total of 161 species were herbs, 14 were shrubs, and only six were trees. Asteraceae with 14 species and Poaceae with 24 species were the largest family in Magnoliopsida and Liliopsida, respectively. *Amaranthus* L., *Persicaria* (L.) Mill., *Solanum* L. and *Lindernia* All. with four species each were appeared as the best representative genera in Mangoliopsida, while *Cyperus* L. with five species in Liliopsida. The species composition and diversity of abandoned brickfields were found to be higher than those of functional brickfields. A total of 42 (23.20%) species were common in both abandoned and functional brickfields of this region. Species composition in the abandoned brickfields of Savar and Dhamrai was mostly similar (64.15%). This study suggests to control and monitor the brickfields under the respective authorities to favor the formation and regeneration of natural vegetation in their neighboring areas.

Key words: Floristic composition, Brickfields, Savar-Dhamrai.

INTRODUCTION

Biodiversity provides all basic ecosystem services, and many valuable components for sustainable development programs throughout the world. This natural resources is being studied by the scientists in several fields (Haidari, 2013; Radaei & Amini, 2013; Singh & Kumar, 2013) for exploring the data from different perspectives with different hypotheses. Higher genetic and species diversity tends to make ecosystems more resistant and resilient to the disturbances and adverse changes, and thus ensures their natural functionality and numerous critical services consistently.

The brickfield areas are one kind of semi-urban to rural disturbed areas of Bangladesh that are surrounded mostly by the vegetation of fallow lands and agricultural fields neighboring to the homesteads.

The brick-making industries in Bangladesh producing about 8.7 billion bricks annually are arbitrarily established in different areas throughout the country. These are the best described as “footloose” industries with seasonal production confined to the six dry

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months of the year, outdated technology, low labor productivity, non-existent capitalization, and informal management.

The effluents from the brickfields might affect the biodiversity and the air quality of their surrounding and neighboring areas. Because, the respiration and photosynthesis processes in the plants might be affected by the deposition of heat, soot, and smoke particles released from these brickfields on their leaves (Alam *et al*., 2006; Jensen & Peppard, 2004; Le & Oanh, 2010). Additionally, the soil pit excavation makes agricultural areas more vulnerable to the erosive floods which may prevent cultivated land to be enriched by sediment deposition (Alam *et al*., 2006), and as the consequences, the soil surface might be transformed irreversibly (Singh & Asgher, 2005). On the other hand, the use of substantial amounts of fuel wood in brick-making industries accelerates deforestation and leads to intensify the emission of Greenhouse Gases (GHGs), such as Carbon dioxide (CO_2), Carbon monoxide (CO), Methane (CH_4), Nitrous oxide (N_2O), and Nitric oxide (NO; Nitrogen oxide) (Alam & Starr, 2008). Brick kilns are also associated with SO_2, volatile organic compounds, and heavy metals depending on the type of fuel burnt. The contribution of brick kiln emissions to the ambient air quality is estimated from the source apportionment studies (Begum *et al*., 2006, 2008, 2011) that estimated an average contribution of 30–40% originating from brick kilns to total ambient PM 2.5 pollution. Brick kiln emissions form a major source of pollution measured over the Dhaka Metropolitan Area (DMA). It has been estimated that at least 35 % of ambient PM10 and at least 15 % of the ambient PM 2.5 in DMA is associated with brick kiln emissions (Azkar *et al*., 2012). Though numerous brickfields are functional in different areas of Bangladesh, it is yet unknown whether the operation of the brickfields has any impact on the composition and diversity of the plant species growing in their surroundings or neighboring areas, and in what extent they affect this valuable natural resource.

The importance of studying local floristic diversity has been realized and carried out in Bangladesh by many researchers (Khan *et al*., 1994; Rahman & Hassan, 1995; Uddin & Rahman, 1999; Khan & Huq, 2001; Uddin & Hassan, 2010). Some of the floristic studies have been conducted on the plain land areas that harbor the brickfields too (Rahman & Hassan, 1995; Alam *et al*., 2006; Rahman *et al*., 2012; Rahman 2013; Rahman *et al*., 2013; Sarker *et al*., 2013; Khanam *et al*., 2020; Roy & Khan, 2020). However, there is a lack of data on the floristic composition in and around the brickfield areas in comparison to that of other plain land areas in Bangladesh. Therefore, this study was conducted to know the variation in floristic composition with regard to taxonomic enumeration and species diversity of vascular plants in and around the functional and abandoned brickfield areas of Savar-Dhamrai region.

MATERIALS AND METHODS

The study area belongs to Savar and Dhamrai upazilas of Dhaka district. Savar upazila, with the elevation of 03-20 meter, is located in 23°44'45.1"-24°01'56.5"N and 90°11'11.4"-90°21'18.8" and Dhamrai upazila, with the elevation of 04-15 meter, is situated in 23°49'42.5"-24°02'38.6"N and 90°00'18.1"-90°14'45.4"E (https://elevation.

maplogs.com; www.google.com/maps; http://dhaka.gov.bd). Though, the topography of Savar-Dhamrai region is plain to irregularly elevated and the height of land gradually increases from the east to the west and south to the north, the sampling sites of this study, composed of about 380 hectares of land, were confined to the mostly homogenous plain and fallow land areas of the region harboring different functional and abandoned brickfields (Fig. 1).

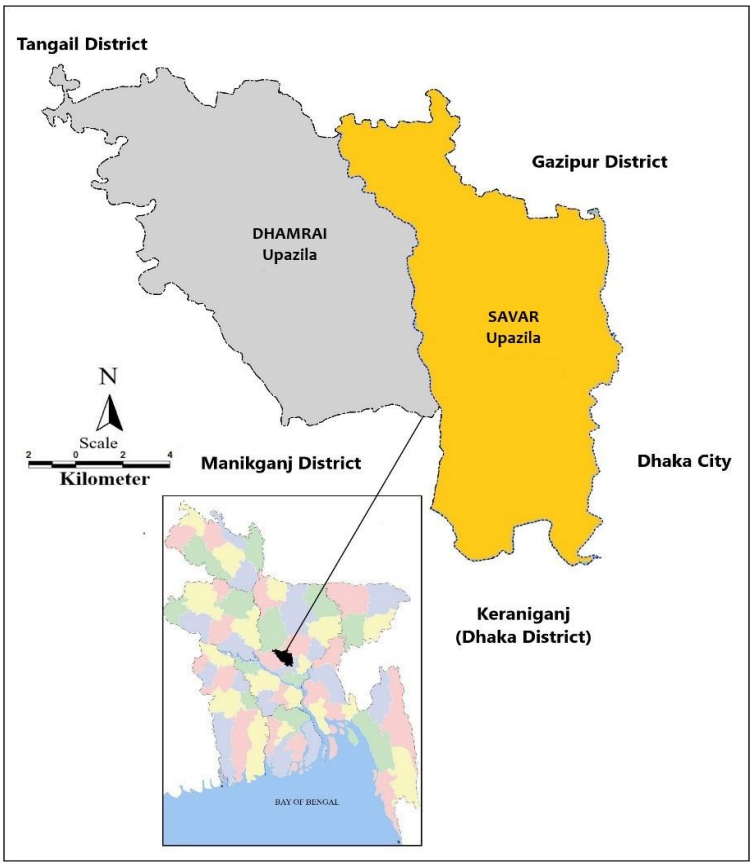

Fig.1. Map of the study area

The land of Savar- and Dhamrai region is composed of alluvium soil of the Pleistocene period (http://dhaka.gov.bd). The main rivers crossing this region are Dhaleshwari, Bangshi, Turag and Karnatali, and other rivers include Kolmai, Gazikhali, and Buriganga. These rivers are mostly polluted by industrial and sewerage wastes and residues of insecticides or herbicides etc. The soil of this region consists of heterogeneous assortment of silt, sand, clay, and gravel and often contains a good deal of organic matter due to which the land of the area is very fertile. The crest soils are represented by brownish grey, dark grey- and grey fine sandy loam soil. Consistency of dry soil is hard,

moist soil is slightly firm to friable, while nature of wet soil is slightly sticky or plastic (Hossain *et al*., 2003). This region has a hot, wet and humid tropical climate, monthly humidity varies from 39% in January-February up to 92% in July-August, temperature ranges from 13°C in January-December to 39ºC in April-May and total rainfall from 0.6 mm in November-December to 350.80 mm in June-July (*www.worldweatheronline.com*).

Specimens Collection and Preservation: About five hundred fresh specimens representing different taxa were collected from various habitats through the field trips conducted throughout the study area covering different seasons. The specimens were collected only from the healthy twigs with bud, flowers and fruit. The collected specimens were dried and processed using standard herbarium techniques (Bridson & Forman, 1989; Singh & Subramaniam, 2008). The voucher specimen of each taxon was selected considering the best representation of the vegetative and reproductive characters. All relevant field information, *viz*. collection date, locality, habit, habitat, stem height, size, shape, color and odor of the flowers and/or fruits, phenology, distribution, and uses etc. were recorded in the notebook. The dried and mounted specimens are deposited in Jahangirnagar University Herbarium (JUH).

In order to assess the existing plant species diversity in different brickfield areas, quantitative field data were collected through quadrat sampling following the standard quadrat method (Braun-Blanquet, 1932; Raunkiaer, 1934; Cottam *et al*., 1953; Cottam & Curtis, 1956; Krebs, 1989). The standard size (1m²) of the quadrat was determined following the 'Species Area Curve' (Cain, 1938; Braun-Blanquet, 1964).

Specimens Examination and Identification: All plant specimens were preliminarily identified through consulting the experts and matching with relevant voucher specimens preserved at Jahangirnagar University Herbarium (JUH). Taxonomic identification of the specimens were confirmed through matching them with the relevant type images available in the websites of different international herbaria (K, P, G), voucher specimens housed in Bangladesh National Herbarium (DACB), and respective taxonomic descriptions and keys available in standard taxonomic literature (Hooker, 1872-1897; Prain, 1903; Nasir & Ali, 1980-2005; Wu *et al*., 1999-2013; Siddiqui *et al*., 2007; Smitinand & Larsen, 1975, 1989; Ahmed *et al*., 2008-2009; Watson *et al*., 2011; Flora of North America Editorial Committee, 1993-2014). Information on different taxa and their distribution in Bangladesh were verified following Khan (1972-1987), Khan & Halim (1987), Siddiqui *et al*. (2007) and Ahmed *et al*., (2008-2009).

Nomenclatural Information Collection: The updated nomenclatural information of all identified taxa was verified through consulting recent taxonomic publications (Nasir & Ali, 1980-2005; Wu *et al*., 1999-2013; Watson *et al*., 2011) and nomenclatural databases (IPNI, 2019; The Plant List, 2013; TROPICOS, 2020). The local name/s of plant species were based on Huq (1986), Pasha & Uddin (2013) and interviews with the local people. The angiosperm families are arranged following the classification system of Cronquist (1981), whereas the families of pteridophytes according to the classification system of Pichi (1977). All genera and species are arranged alphabetically.

Data Analyses: Species diversity was calculated using two diversity indices, *viz*. Shannon's index (Shannon, 1948) and Simpson's index (Simpson, 1949), using the following formulae:

Shannon's diversity index

$$H' = -\sum p_i \ln (p_i)$$

Where, H' = the Shannon diversity index
pi = the total number of individuals of a particular species/ the total number of individuals of all species
ln = Log base n
Σ = sum from species 1 to species S (numbers of species encountered).

Simpson's diversity index $D = 1- \Sigma n (n-1)/N (N-1)$

Where, D = the Simpson diversity index; value ranges between 0 and 1, 0 being no diversity and 1 represents infinite diversity
N = the total number of individuals of all species
n = the total number of individuals of a particular species
Σ = sum from species 1 to species S (numbers of species encountered).

The similarity between the plant species composition of abandoned and functional brickfield areas was estimated by Jaccard coefficient index using the following formula (Jaccard, 1912; Glen, 2016):

$$\text{Jaccard Index} = \frac{\text{The number of species shared by both sites}}{\text{Total number of species present in both sites}} \times 100$$

RESULTS AND DISCUSSION

Floristic composition: A total of 181 species, belonging to 133 genera and 51 families, were found in and around the brickfields of Savar-Dhamrai region of Dhaka district. A total 148 species (81.77%) were recorded from Savar area and 161 species (88.95%) from Dhamrai area, whereas total 128 species (70.72%) were commonly shared by these two areas. In the brickfields of Savar-Dhamrai region, the pteridophytes were represented by six species belonging to six genera and five families, the dicotyledons were composed of 128 species belonging to 96 genera and 40 families and the monocotyledons were consisted of 47 species belonging to 31 genera and six families. Among these, the herbs comprised 161 species (88.95%) that were followed by shurbs of 14 species (7.73%) and trees of six species (3.32%) (Table 1).

During this study, a total of 125 species (84.46%) were recorded from the abandoned and 75 species (50.67%) from the functional brickfields of Savar area, while 52 species (35.13%) were commonly shared by these two types of brickfields. In Dhamrai area, a total of 136 (84.47%) species were appeared in the abandoned brickfields and only 80 species (49.69%) in the functional brickfields, whereas 55 (34.16%) species were common in abandoned and functional brickfields of this area. A total of 42 species were common in and around the abandoned- and functional brickfield areas of Savar-Dhamrai region. 11 species exclusively occurred in the abandoned brickfields of Savar and 19 in those of Dhamrai, whereas six species in the functional brickfields of both Savar and Dhamrai areas.

These data indicate that the number of vascular plant species in and around the abandoned brickfields of Savar-Dhamrai region was much higher than that in and around the functional brickfields of this region and the brickfields of Dhamrai area harbored somewhat higher number of vascular plant species in respect to the brickfields of Savar area.

Table 1. List of Vascular Plants of brickfield areas of Savar-Dhamrai region of Dhaka district of Bangladesh

Scientific name	Bangla name	Habit	Occurrence	Uses	Brickfield
MAGNOLIOPSIDA Brongn.					
PIPERACEAE Giseke					
Peperomia pellucida (L.) Kunth	Pithapata	Herb, e	O	M	All
MENISPERMACEAE Juss.					
Stephania japonica (Thunb.) Miers	Akandi manik	Herb, cl	C	M	AbD, FuD, AbS
ULMACEAE Mirb.					
Trema orientalis (L.) Blume	Jiban, Banjiga	Tree, m	O	Fw, Fd	FuD, AbS
MORACEAE Gaudich.					
Ficus heterophylla L.f.	Bhui dumur	Shrub	C	W	AbD
F. hispida L.f.	Kak dumur	Shrub	R	M	All
Streblus asper Lour.	Sheora	Tree, s	C	M	AbD, AbS, FuS
URTICACEAE Juss.					
Pilea microphylla (L.) Liebm.	Latamaricha	Herb, pr	C	M	All
Pouzolzia zeylanica (L.) Benn.	Kullaruki	Herb, pr	C	M	AbD, FuD
AMARANTHACEAE Juss.					
Achyranthes aspera L.	Apang	Herb, e	R	M	AbD, AbS
Alternanthera paronychioides A. St.-Hil.	Jhuli khata	Herb, pr	R	M	FuD, FuS
A. philoxeroides (Mart.) Griseb.	Henchi	Herb, aq	C	V	All
A. sessilis (L.) R.Br. ex DC.	Malancha	Herb, aq	C	V	AbD, FuD, AbS
Amaranthus blitum L.	Goburanotey	Herb, pr	C		FuD
A. spinosus L.	Kantanotey	Herb, e	C	V, M	All
A. tricolor L.	Lalshak	Herb, e	O	V	AbD, AbS
A. viridis L.	Notey shak	Herb, e	C	V	AbD
Cyathula prostrata (L.) Blume	Shyontula	Herb, pr	C	M	AbS
PORTULACACEAE Juss.					
Portulaca oleracea L.	Boronunia	Herb, pr	R	M	All
BASELLACEAE Raf.					
Basella alba L.	Pui shak	Herb, cr	C	V	AbD, AbS
MOLLUGINACEAE Bartl.					
Glinus oppositifolius (L.) Aug. DC.	Gima Shak	Herb, pr	O	M	All

Scientific name	Bangla name	Habit	Occurrence	Uses	Brickfield
Mollugo pentaphylla L.	Khetpapra	Herb, pr	O	M, V	AbD, FuS
CARYOPHYLLACEAE Juss.					
Polycarpon prostratum (Forssk.) Asch. & Schweinf.	Ghima	Herb, pr	O	M	FuD, FuS
POLYGONACEAE Juss.					
Persicaria hydropiper (L.) Delarbre	Biskatali	Herb,e	O	M	All
P. lapathefolia (L.) Delarbre	Pani-bishkatali	Herb, e	C	M	AbD, AbS
P. minor (Huds.) Opiz	Chhoto-bishkatali	Herb, e	O	-	AbD, FuD
P.orientalis (L.) Spach	Bara panimarich	Herb, e	C	-	AbD, AbS
Polygonum effusum Meisn.	Raniphul	Herb, e	O	M	AbD, AbS
P. plebeium R.Br.	Khudi-bishkatali	Herb, e	O	O	AbD, FuD
P. praetermissum Hook. f.	Fota bishkatali	Herb, e	O	-	AbD, AbS
Rumex dentatus L.	Bon-palang	Herb, e	C	M	AbD, AbS
R. maritimus L.	Dati-palang	Herb, e	C	M	AbD, AbS
TILIACEAE Juss.					
Triumfetta rhomboidea Jacq.	Bon Okra	Herb, e	C	M	All
STERCULIACEAEVent.					
Melochia corchorifolia L.	Tiki-okra	Herb, e	O	M	AbD, FuD
MALVACEAE Juss.					
Corchorus aestuans L.	Janglipat	Herb, e	O	V	AbD, AbS
Urena lobata L.	Banghagra	Shrub	C	M	All
Sida rhombifolia L.	Lal berela	Herb, e	C	-	All
CUCURBITACEAE Juss.					
Coccinia grandis (L.) Voigt	Telakucha	Herb, cl	C	M	AbD, AbS
Cucumis sativus L.	Khira	Herb, cr	R	V	AbD
Luffa cylindrica (L.) M.Roem.	Dhundal	Herb, cl	C	V	AbD, AbS
Mukia maderaspatana (L.) M.Roem.	Bilari	Herb, cl	C	-	AbD, AbS
Trichosanthes tricuspidata Lour.	Makal	Herb, cl	O	M	AbD
BRASSICACEAE Burnett					
Rorippa indica (L.) Hiern	Bansarisha	Herb, e	O	V	All
CLEOMACEAE Bercht. & J. Presl					
Cleome rutidosperma DC.	Begunehurhurey	Herb, e	C	W	AbD, AbS
C. viscosa L.	Atha hurhuria	Herb, e	R	W	AbD
MIMOSACEAE R.Br.					
Acacia auriculiformis Benth.	Akashmoni	Tree, l	C	T	All
Mimosa pudica L.	Lajjaboti	Shrub	O	M	All
CAESALPINIACEAE R.Br.					
Senna occidentalis (L.) Link	Barakalkesunda	Shrub	C	M	AbD, AbS
S. sophera (L.) Roxb.	Kalkeshunda	Herb, e	O	M	AbD, FuD
S. tora (L.) Roxb.	Terasena	Herb, e	C	M	All
FABACEAE Lindl.					
Aeschynomene indica L.	Bhatshola	Herb, e	O	Gm	AbD, AbS
Cajanus cajan (L.) Millsp.	Arhar	Shrub	O	Pu, Gm	AbD
Desmodium triflorum (L.) DC.	Kulalia	Herb, pr	C	M	All
Sesbania cannabina (Retz.) Pers.	Dhonchi	Herb, e	R	Gm	AbD
Tephrosia candida (Roxb.) DC.	Bilakshani	Herb, e	R	M, Gm	AbS
Vicia hirsuta (L.) Gray	Masurechana	Herb, cl	O	Fd	AbD, AbS
Vigna mungo (L.) Hepper	Maskalay	Herb, e	O	Pu, Fd	AbD
LYTHRACEAE J. St.-Hil.					
Rotala rotundifolia (Buch.-Ham. ex Roxb.) Koehne	Dim ghurni	Herb, cr	C	-	AbD, AbS
ONAGRACEAE Juss.					

Scientific name	Bangla name	Habit	Occurrence	Uses	Brickfield
Ludwigia adscendens (L.) H. Hara	Keshordam	Herb, cr	O	W	AbD, AbS
L. hyssopifolia (G. Don) Exell	Panipalong	Herb, e	O	W	AbD, FuS
L. perennis L.	Amorkura	Herb, e	C	W	AbD, AbS
MAZACEAE Reveal					
Mazus pumilus (Burm. f.) Steenis	Tutra	Herb, pr	C	-	AbD, FuD, AbS
EUPHORBIACEAE Juss.					
Croton bonplandianus Baill.	Banmarich	Herb, e	C	M	All
Euphorbia hirta L.	Bara dudhia	Herb, pr	C	M	All
E. thymifolia L.	Dudhia	Herb, pr	C		FuD
Phyllanthus niruri L.	Vuiamla	Herb, e	C	M	All
P. reticulatus Poir.	Chitki	Shrub	O	M	FuS
P. urinaria L.	Hazarmani	Herb, e	O	M	FuD, FuS
Ricinus communis L.	Bherenda	Shrub	O	M, Ol	AbD, AbS
RHAMNACEAE Juss.					
Ziziphus mauritiana Lam.	Bol boroi	Tree, s	O	M	AbD, FuD
OXALIDACEAE R. Br.					
Oxalis corniculata L.	Amrul	Herb, cr	C	V,M	AbD, AbS
APIACEAE Lindl.					
Centella asiatica (L.) Urb.	Thankuni	Herb, cr	O	M	AbD, AbS
Oenanthe benghalensis Benth. & Hook. f.	Bon-dhonia	Herb, e	C	-	AbD
MELIACEAE Juss.					
Toona ciliata M. Roem.	Toon	Tree, l	O	T	AbD
SOLANACEAE Juss.					
Datura stramonium L.	Sada dhutra	Shrub	R	M	AbD
Physalis angulata L.	Futka	Herb, e	C	-	All
Solanum americanum Mill.	Tit-begun	Herb, e	C	M	FuD, FuS
S. melongena L.	Begun	Herb, e	O	V	FuD, FuS
S. surattense Burm. f.	-	Herb, e	R	-	AbS
S. torvum Sw.	Gota begun	Herb, e	C	-	FuD, FuS
Nicotiana plumbaginifolia Viv.	Ban tamak	Herb, e	O	-	AbD, AbS
CONVOLVULACEAE Juss.					
Evolvulus nummularius (L.) L.	Bhui okra	Herb, cr	C	-	All
Ipomoea aquatica Forssk.	Kalmishak	Herb, pr	C	V	AbD, AbS
I. carnea Jacq.	Dhol Kolmi	Shrub	O	-	AbD, AbS
MENYANTHACEAE Dumort.					
Nymphoides hydrophylla (Lour.) Kuntze	Chand mala	Herb, aq	C	W	AbD, AbS
N. indica (L.) Kuntze	Panchuli mala	Herb, aq	C	W	AbD, AbS
BORAGINACEAE Juss.					
Heliotropium indicum L.	Hatisur	Herb, e	C	M	AbD, FuD, AbS
VERBENACEAE J. St.-Hil.					
Phyla nodiflora (L.) Greene	Vuiokra	Herb, cr	C	M	AbS, FuS
Lantana camara L.	Kutuskanta	Shrub	R	M	AbD, AbS
Lippia alba (Mill.) N.E.Br. ex Britton & P.Wilson	Pichas-lakri	Shrub	C		FuD, FuS
LAMIACEAE Martinov					
Clerodendrum infortunatum L.	Bhat	Shrub	C	M	AbD, AbS
Hyptis capitata Jacq.	Tata tokma	Herb, e	C	W	FuD, FuS
H. suaveolens (L.) Poit.	Tokma	Herb, e	C	M	AbD, AbS
Leucas zeylanica (L.) W.T. Aiton	Dondokalosh	Herb, e	O	M	All
Leonurus sibiricus L.	Rokto-dron	Herb, e	R	W	FuD
Ocimum americanum L.	Bantulsi	Herb, e	O	M	AbD, AbS, FuS
Pogostemon auricularius (L.) Hassk.	Aripachuli	Herb, e	O	M	AbS

Scientific name	Bangla name	Habit	Occurrence	Uses	Brickfield
PLANTAGINACEAE Juss.					
Limnophila heterophylla (Roxb.) Benth.	Patakutra	Herb, e	O	W	FuD
Mecardonia procumbens (Mill.) Small	Micardan	Herb, cr	C	W	FuD, AbS
Scoparia dulcis L.	Bondhone	Herb, e	O	M	All
LINDERNIACEAE Borsch, Kai Müll. & Eb. Fisch.					
Lindernia antipoda (L.) Alston	Zai ghas	Herb, pr	C	W	AbD, AbS
L. ciliata (Colsm.) Pennell	Bhui papri	Herb, pr	C	-	AbD, AbS, FuS
L. crustacea (L.) F.Muell.	Chapra ghas	Herb, pr	C	-	All
L. rotundifolia (L.) Alston	Tan chapra	Herb, e	C	-	AbD, AbS
ACANTHACEAE Juss.					
Hemigraphis hirta (Vahl) T. Anderson	Buripana	Herb, pr	R	M	All
Hygrophila erecta (Burm.f.) Hochr	Filareck	Herb, e	O	W	FuD, AbS
H. polysperma (Roxb.) T. Anderson	Alai kalai	Herb, pr	O	W	AbD, AbS
Nelsonia canescens (Lam.) Spreng.	Paramul	Herb, e	C	-	FuS
Rungia pectinata (L.) Nees	Pindi	Herb, pr	O	M	All
PEDALIACEAER. Br.					
Sesamum indicum L.	Til	Herb, e	O	M	AbD, AbS
RUBIACEAE Juss.					
Catunaregam spinosa (Thunb.) Tirveng.	Mankanta	Shrub	C	M	AbS, FuS
Dentella repens (L.) J.R.Forst. & G.Forst.	Bhuipat	Herb, pr	C	-	FuS
Oldenlandia corymbosa L.	Khet papra	Herb, pr	C	-	AbD, FuD
O. diffusa (Willd.) Roxb.	Fussa papra	Herb, pr	C	-	AbD
Richardia scabra L.	Nakli ipecac	Herb, e	R	-	FuD
ASTERACEAE Bercht. & J. Presl					
Ageratum conyzoides (L.) L.	Fulkuri	Herb, e	C	M	All
Bidens pilosa L.	Bidenlosa	Herb, e	R	W	AbD
Blumea lacera (Burm.f.) DC.	Barokukshim	Herb, e	O	M	AbD, AbS
Cyanthillium cinereum (L.) H.Rob.	Shialmutra	Herb, e	O	M	All
Eclipta prostrata (L.) L.	Kalokeshi	Herb, pr	C	M	All
Enydra fluctuans DC.	Helencha	Herb, pr	C	V	FuD, AbS
Grangea maderaspatana (L.) Poir.	Namuti	Herb, e	O	M	AbD, FuS
Mikania micrantha Kunth	Assamlata	Herb, cl	C	M	AbD, AbS
Sonchus arvensis L.	Chashar	Herb, e	R	W	AbD
Spilanthes acmella (L.) L.	Mahatitinga	Herb, pr	C	O, M	AbD, AbS, FuS
Synedrella nodiflora (L.) Gaertn.	Nakphul	Herb, e	C	-	All
Tridax procumbens (L.) L.	Tridhara	Herb, e	C	M	AbD, FuS
Xanthium strumarium L.	Ghagra	Herb, e	C	-	AbD, AbS
Youngia japonica (L.) DC.	Youngaful	Herb, e	R	-	FuD, AbS, FuS
LILIOPSIDABatsch					
ARECACEAE Bercht. & J. Presl					
Phoenix sylvestris (L.) Roxb.	Deshi khejur	Tree, l	C	Fw, Ju	AbD, AbS
ARACEAEJuss.					
Colocasia esculenta (L.) Schott	Jangli kachu	Herb, e	C	V, M	AbD, AbS
Lemna minor L.	Sujipana	Herb, aq	C	Gm	AbS
L. perpusilla Torr.	Khudipana	Herb, aq	C	Gm	AbD, AbS
Pistia stratiotes L.	Topapana	Herb, aq	C	Gm	AbD, AbS
Typhonium flagelliforme (Lodd.) Blume	Ghechu	Herb, e	C	V	AbD, FuS
COMMELINACEAEMirb.					

Scientific name	Bangla name	Habit	Occurrence	Uses	Brickfield
Commelina benghalensis L.	Kanshira	Herb, e	O	M	All
C. diffusa Burm.f.	Monayna kanshira	Herb, e	C	M	FuD, FuS
C. longifolia Lam.	Pani kanshira	Herb, pr	C	W	AbS
Murdannia nudiflora (L.) Brenan	Kureli	Herb, e	O	-	FuS
CYPERACEAE Juss.					
Cyperus difformis L.	Behua ghasi	Herb, e	C	W	All
C. haspan L.	Haspan ghasi	Herb, e	C	W	AbS
C. iria L.	Barachucha	Herb, e	C	Sb	FuD, AbS
C. laxus Lam.	Alga ghasi	Herb, e	C	Sb	FuD
C. rotundus L.	Nagarmutha	Herb, e	C	Sb	All
Cyanotis axillaris (L.) D.Don ex Sweet	Axinot	Herb, cr	C	W	AbS
Fimbristylis bisumbellata (Forssk.) Bubani	Bisu fimbry	Herb, e	C	W	FuD, AbS
F. dichotoma (L.) Vahl	Bara nirbishi	Herb, e	C	W	All
F. quinquangularis (Vahl) Kunth	Pachkona fibmry	Herb, e	O	W	AbD, AbS
F. schoenoides (Retz.) Vahl	Kesari Malanga	Herb, e	C	-	AbD, FuD, AbS
Kyllinga nemoralis (J.R.Forst. & G.Forst.) Dandy ex Hutch. & Dalziel	Subashinirbisa	Herb, e	C	Fd	AbD, AbS, FuS
POACEAE Barnhart					
Apluda mutica L.	Matica	Herb, e	R	Fd	AbS
Chrysopogon zizanioides (L.) Roberty	Bena	Herb, e	O	Fd, Sb	AbD, FuS
Cynodon dactylon (L.) Pers.	Durba ghas	Herb, pr	C	Fd, Sb	All
Dactyloctenium aegyptium (L.) Willd.	Kakpaya	Herb, e	O	-	FuD, AbS, FuS
Digitaria bicornis (Lam.) Roem. & Schult.	Baikochira	Herb, e	C	Sb	AbD
D. ciliaris (Retz.) Koeler	Kokjachira	Herb, e	C	-	All
D. sanguinalis (L.) Scop.	Mukurjoli	Herb, e	O	-	All
Echinochloa colona (L.) Link.	Shama Ghas	Herb,e	C	Fd	AbD, FuD
Eleusine indica (L.) Gaertn.	Malankuri	Herb, e	C	Fd	All
Eragrostis amabilis (L.) Wight & Arn.	Koni ghas	Herb, e	O	Fd, Sb	AbD
E. cilianensis (All.) Janch.	Dudh-nol	Herb, e	O	W	FuS
E. unioloides (Retz.) Nees ex Steud.	Chirakoni	Herb, e	C	Fd, Gm	All
Hygroryza aristata (Retz.) Nees ex Wight & Arn.	Jongli dhan	Herb, e	O	W	AbD, AbS
Imperata cylindrica (L.) Raeusch.	Chhan	Herb, e	C	Fd,M	All
Leersia hexandra Sw.	Fulka ghas	Herb, cr	C	Fd	AbS
Oryza rufipogon Griff.	Bunodhan	Herb, e	R	Fd	AbD
O. sativa L.	Dhan	Herb, e	O	Fd	AbD
Ottochloa nodosa (Kunth) Dandy	Voyal ghas	Herb, e	O	-	AbS
Paspalum conjugatum P.J. Bergius.	Moisshya ghas	Herb, e	C	-	AbS, FuS
P. scrobiculatum L.	Bishmona ghas	Herb, e	C	-	FuS
Pennisetum glaucum (L.) R.Br.	Kawni	Herb, e	C	Fd	AbD, AbS
Rottboellia cochinchinensis (Lour.) Clayton	Boro-sowati ghas	Herb, e	O	Fd	AbD
Saccharum spontaneum L.	Kash	Herb, e	O	Fw	AbD, AbS
Setaria pumila (Poir.) Roem. & Schult.	Halde kawn	Herb, e	O	Fd	FuD, FuS
PONTEDERIACEAE Kunth					

Scientific name	Bangla name	Habit	Occurrence	Uses	Brickfield
Eichhornia crassipes (Mart.) Solms	Kachuripana	Herb, aq	C	Gm	AbD, AbS
Monochoria hastata (L.) Solms	Bara nukha	Herb, aq	C	Fd	AbD, AbS
PTERIDOPHYTA Schimp.					
SALVINIACEAE Martinov					
Salvinia cucullata Roxb.	Indur kani	Herb, aq	C	Gm	AbD, AbS
MARSILEACEAE Mirb.					
Marsilea minuta L.	Susni shak	Herb, cr	C	M	All
LYGODIACEAE M. Roem.					
Lygodium flexuosum (L.) Sw.	Saralata fern	Herb, cr	C	W	AbD, AbS
PTERIDACEAE E.D.M. Kirchn.					
Ceratopteris thalictroides (L.) Brongn.	Pani lettuce	Herb, aq	O	V	FuD, AbS
Pteris vittata L.	Imoditeris	Herb, pr	C	W	All
THELYPTERIDACEAE Ching ex Pic. Serm.					
Ampelopteris prolifera (Retz.) Copel.	Lombo dheki shak	Herb, cr	C	V	AbD, FuS

Note: **Habit:** aq = aquatic, cl = climber, cr = creeping, e = erect, l = large, m = medium, pr = prostrate, s = small. **Occurrence:** C = Common, O = Occasional, R = Rare**. Use:** Fb = fibre, Fd = fodder, Fw = fuel wood, Gm = green manure, Ju = juice M = medicine, O = ornamental, Pu = pulse, Ol = oil, Sb = soil binder, T = timber, and V = vegetable, W = weed**. Brickfield Type:** AbD = abandoned brickfield of Dhamrai; FuD = functional brickfield of Dhamrai; AbS = abandoned brickfield of Savar; FuS = functional brickfield of Savar. All = AbD, FuD, AbS and FuS.

In the pteridophytes of the studied brickfield areas, Pteridaceae was the largest family with two species only, while Salviniaceae, Marsileaceae, Lygodiaceae and Thelypteridaceae were represented by a single species each.In Magnoliopsida (dicotyledons), Asteraceae with 14 species was the largest family followed by Amaranthaceae, and Polygonaceae with nine species each; while Poaceae with 24 species was the largest family in Liliopsida (monocotyledons), followed by Cyperaceae with 11 species. *Amaranthus* L. of Amaranthaceae, *Lindernia* All. of Linderniaceae, *Persicaria* Mill. of Polygonaceae and *Solanum* L. of Solanaceae with four species each were the largest genera in Magnoliopsida, whereas, *Cyperus* L. of Cyperaceae with five species was the largest genus in the Liliopsida. In Magnoliopsida, the genera *Alternanthera* Forssk., *Polygonum* L., *Ludwigia* L., *Phyllanthus* L. and *Senna* Mill. were found with three species each; while *Ficus* L., *Rumex* L., *Cleome* L., *Euphorbia* L., *Ipomoea* L., *Nymphoides* Ség., *Hyptis* Jacq., *Hygrophilla* R. Br. and *Oldenlandia* L. with two species each. A total of 47 genera were appeared with single species each. *Alternanthera spinosus*, *Cynodon dactylon*, *Cyperus rotundus*, *Eclipta prostrata*, *Pilea microphylla*, and *Synedrella nodiflora* etc. were common in the brickfields of Savar and Dhamrai region. Additionally, *Phyla nodiflora* and *Paspalum conjugatum* were common in the brickfields of Savar area, whereas *Pouzolzia zeylanica* and *Echinochloa colona* in those of Dhamrai area.

In Liliopsida, *Fimbristylis* Vahl. was recorded as the largest genus with four species, followed by *Commelina* L., *Digitaria* Haller and *Eragrostis* Host ex Hitchc. with three species each, *Lemna* L., *Oryza* L. and *Paspalum* L. with two species each and a total of

23 genera were represented by a single species each. *Cynodon dactylon*, *Eleusine indica*, *Eragrostis unioloides*, *Fimbristylis dichotoma* and *Cyperus rotundus* etc. were common in the brickfields of Savar and Dhamrai region. *Paspalum conjugatum* was documented as the most common species in the brickfields of Savar, whereas *Echinochloa colona* in the brickfields of Dhamrai area.

During this study, a total of 144 species were recognized as economically important. The major categories of these economically important species were medicinal (67 species), weed (28 species), fodder (20 species), vegetable (19 species), green manure (10 species), soil binder (seven species), fuel wood and oil yielding (three species), and pulse (two species). 16 species were documented as useful in two categories.

The similarity in species composition estimated by Jaccard coefficient shows that the brickfield areas of Savar and Dhamrai were 23.20% similar in the composition of vascular plant species. The highest similarity (64.15%) was shared by the abandoned brickfields of Savar and those of Dhamrai which was followed by that shared by the functional brickfields (53.46%) of these two areas. The similarity between the functional and abandoned brickfields of Savar area was closer to those of Dhamrai area (Fig. 2).

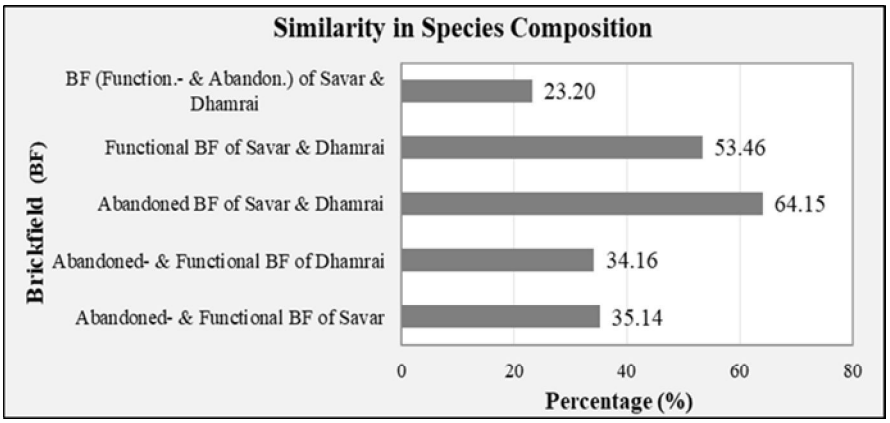

Fig. 2. Similarity between the brickfields of Savar-Dhamrai region in species composition based on Jaccard Coefficient (Jaccard, 1912)

The result shows that the flora of all brickfield areas of Savar and Dhamrai region covered by this study seem to be poor in species composition in respect to that of some forest areas (Arefin *et al*., 2011) and semi-urban to rural areas (Sultana *et al*., 2013). The taxonomic enumeration of the species extant in the study area seems somewhat higher than that of few previous records from forest areas (Rashid & Mia, 2001; Rahman & Hassan, 1995; Uddin & Hassan, 2010) and semi-urban or rural areas (Anonymous, 2012a; Anonymous, 2012b; Rahman *et al*., 2012), if the size of the sampling area is considered.

Species diversity: The calculated values of Shannon's and Simpson's diversity indices for functional and abandoned brickfields of the study area show that species diversity of the sampling sites was increased in increase of their distance up to certain level (ca. 550 ft) from the brickfields and the abandoned brickfield areas harbored much higher species diversity than that of functional brickfield areas (Figs. 3 and 4).

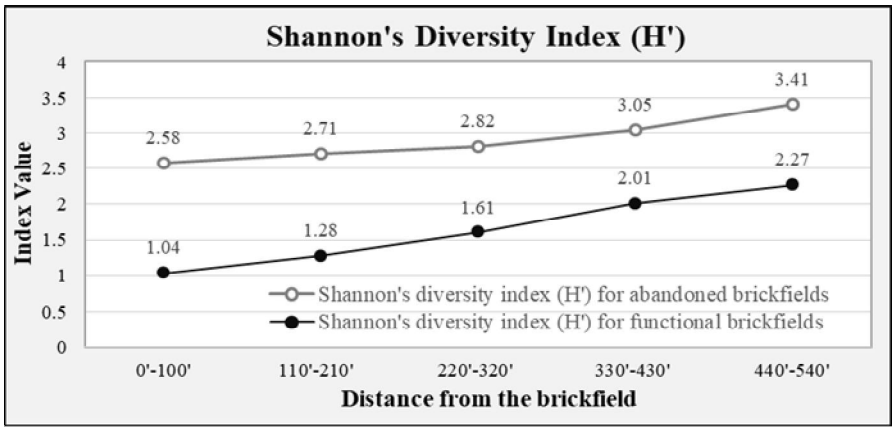

Fig. 3. Comparison between functional and abandoned brickfields of Savar-Dhamrai areas in species diversity of vascular plants based on Shannon's diversity index values

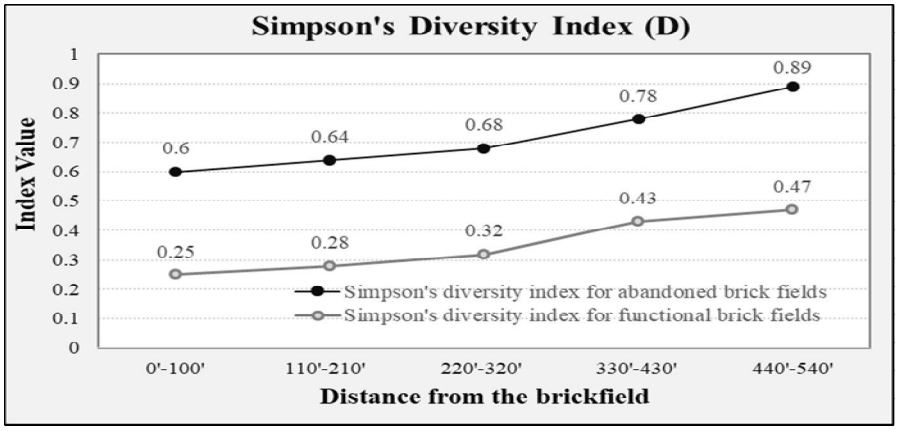

Fig. 4. Comparison between functional and abandoned brickfields of Savar-Dhamrai areas in species diversity of vascular plants based on Simpson's diversity index values

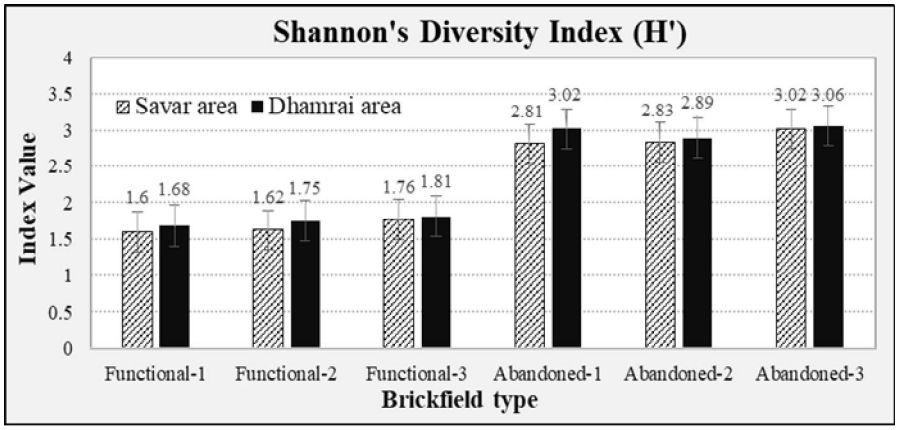

Fig. 5. Variation in Shannon's diversity index values for the vascular plants of functional and abandoned brickfields of three representative sites of each of Savar- and Dhamrai upazilas

The calculation of Shannon index (Fig. 3) shows that the diversity value of the adjacent or nearest area of abandoned brickfields (0'-100' distance) was 2.58, whereas, for functional field was 1.04. The species diversity of abandoned and functional brickfields at more than 100' distance were found to be increased up to 3.41 and 2.27 at 440'-540' distance, respectively, and after that the difference in species diversity of these two types of brickfields was gradually decreased. These data indicate that the functional brickfields harbor less species diversity than that of the abandoned brickfields, especially at their adjacent areas, and this trend is reflected in their neighboring areas up to certain distance. The diversity values based on Simpson's index show the same trend as that of Shannon's index in case of increasing species diversity in abandoned brickfield in respect to functional brickfields at all selected distances in the study area (Fig. 4). The Simpson's diversity index value of abandoned and functional fields of Savar and Dhamrai area at 0'-100' distance is 0.6 and 0.25, respectively, at 110'-210' distance is 0.64 and 0.28, at 220'-320' distance is 0.68 and 0.32, at 330'-430' distance is 0.78 and 0.43 and at 440'-540' distance is 0.89 and 0.47 (Fig. 4).

A comparison between the species diversity of functional and abandoned brickfields of three representative sites of each of Savar- and Dhamrai upazilas based on the average values of Shannon's index (Fig. 5) shows that it is remarkably variable but the functional brickfields harbor lower range of species diversity (1.6-1.81) than that (2.81-3.06) of the abandoned brickfields, and both the functional and abandoned brickfields of Dhamrai area (1.68-1.81 and 2.89-3.06, respectively) harbor somewhat higher species diversity than those of Savar area (1.60-1.76 and 2.81-3.02, respectively), though both of these two upazilas have almost similar type of vegetation.

The species diversity recorded from the studied brickfield areas of Savar and Dhamrai region is consistent with the reports on few forest areas (Rahman & Hassan, 1995; Rashid & Mia, 2001) and semi-urban to rural areas (Alam *et al.*, 2006; Rahman *et al*., 2012; Shetu *et al*., 2018; Nahaer, 2014). To know the exact reasons of the occurrence of higher species composition and diversity of vascular plants in and around the brickfield areas of Savar and Dhamrai region than those of some plain land areas of Bangladesh, as reported by some previous studies, further comparative studies involving more parameters are necessary. However, the dense and mostly herbaceous vegetation cover in most of the fallow lands or abandoned plain lands near or adjacent to the brickfield areas of the region, mode and frequency of functional anthropogenic interferences, and the sampling and data collection methods followed in these studies might be recognized as the potential factors. It is also notable that, once in the past, the study area was almost rural and covered with very dense vegetation, though recently the species composition and floristic diversity of the area have been notably decreased due to different anthropogenic activities.

In respect to different threats to the flora and plant diversity of Savar and Dhamrai region comprising a good number of economically important species, this study suggests to control the establishment new brickfields, make sure the operation of the good quality brickfields and monitor these under the respective authorities. As the consequence of rapid urbanization, agricultural expansion, and increasing industrialization etc., the study area might loss its natural vegetation completely in near future. Therefore, this study recommends to manage the abandoned brickfields properly to favor the formation of natural vegetation there that can serve as the micro-ecosystems and tiny spots of biodiversity in this region. Additionally, undertaking enough initiatives to increase public awareness for the conservation of biological resources in this region is also recommended.

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