# Some Functional Expression on Diameter Distribution, Density and Basal Area of Oak (Quercus semecarpifolia Sm.) Forest in Nepal Himalaya

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# Mahendra Nath Subedi : **Some Functional Expression on Diameter Distribution, Density and Basal Area of Oak (*Quercus semecarpifolia* Sm.) Forest in Nepal Himalaya**

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**Abstract**

The forest of *Quercus semecarpifolia* Sm., a prickly leaved oak, is one of the major forest type confined in temperate region of Nepal. Some basic characteristics of the forest as expressed in diameter distribution, density and basal area value have been studied in relation to present situation both in natural and semi-natural stands. The study has been carried out at six different localities namely Suke Pokhari, Deurali, Shivapuri, Phulchoki, Chotra and Chankheli Lekh representing eastern, central and western part of the country, respectively, with two plots in each region. The study was conducted in 40×40 m plots in all the six localities. Basal area percentage (in relation to ground area) were found to be 0.77, 0.64, 0.73, 0.57, 0.46 and 0.52% from east to west, respectively. Similarly the tree densities were found to be 118, 387, 200, 356, 225 and 87 trees/ha in the respective localities. The results have been compared with similar type of forests in other parts of Nepal. A basal area value of 0.75–0.80% has been found agreeable for the natural forest stand. Need for rational utilization of the mature forest and conservation of the degraded areas has been stressed.

**Key Words** : basal area percentage, DBH, density, Nepal, *Quercus semecarpifolia*.

## Introduction

In Nepal the mountains gain elevation from the southern plain of Terai and extend northward, with successional chains, reaching up to the crest of the Himalaya (above 8000 m) in a short geographical span of around 190 km. As a result of such complex physiographic condition and altitudinal difference there is a formation of vegetation zones differentiated at distinct bioclimatic belts from tropical to alpine one. Among these vegetational bands oak forests have important sharing which are mostly confined in the temperate zone. In regional distribution pattern, *Quercus semecarpifolia* Sm. extends throughout temperate Himalaya but is reported to be absent from Sikkim. In Nepal also this species forms major forest type in temperate belt (Stainton 1972). Owing to increased human activities in the recent decades, these oak forests, particularly dominated by *Q. semecarpifolia,* are in heavy pressure because of high quality fuelwood and fodder value and hence loosing its basic qualities in relation to species richness, composition, standing crop and productivity. Moreover, these forests constitute many valuable species related to economic or medicinal properties, apart from ecosystem value. This has necessitated to grasp some functional properties to understand the status of this forest in present situation.

Forest ecosystem studies are still in juvenile stage in Nepal. Few study reports relevant to the oak forests are found in the publications of Yoda (1967), Kanai *et al*. (1975), Richard (1980), Wiart (1983), etc. as one of the component of vegetation study. Here an attempt has been made to discuss some ecological parameters as expressed in diameter range, density and basal area of the oak (*Quercus semecarpifolia*) forest studied in different parts of Nepal.

## Area of Study

The study areas represent all three major botanical provinces of the country (Fig. 1). The

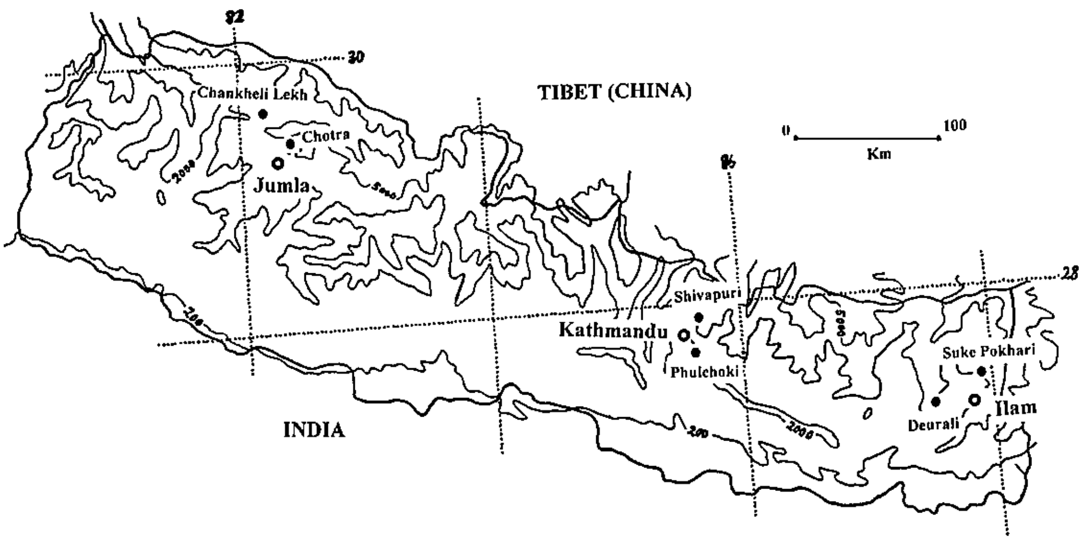


Fig. 1. Surveyed localities (solid circle) and the nearest meteorological stations (open circle).

site of Suke Pokhari (27°5′ N, 87°48′ E) and Deurali (27°7′ N, 87°25′ E) lie in the far eastern part of Nepal. According to Stainton (1972) forest vegetation in the lower part of this area consists *Castanopsis tribuloides* (Sm.) A. DC. and *C. hystrix* Miq., in the middle part *Quercus lamellosa* Sm. and in the upper part *Lithocarpus pachyphylla* (Kurz) Rehder. The site of Shivapuri (27° 48′ N, 85° 23′ E) and Phulchoki (27° 35′ N, 85° 24′ E) lie in Kathmandu valley, in the central part. The lower part of this area lies in Schima / *Castanopsis* zone, the middle part is represented by oak-laurel species and the upper part is dominated by *Q. semecarpifolia* (DMP 1969, 1986). The site of Chotra (29°12′ N, 82°11′ E) and Chankheli Lekh (29°39′ N, 82°7′ E) lie in the remote area of N/W part of Nepal. Due to latitudinal difference i. e. being more northern than other parts of the country and drier climatic condition, this area exhibits some different type of microclimate specific to the regions. Conifer species like *Cedrus deodara* (Roxb. ex D. Don) G. Don, *Picea smithiana* (Wall.) Boiss, etc. make prominent vegetation on the surrounding area (Stainton 1972).

Meteorological data from Ilam, Kathmandu and Jumla shown in Fig. 1 will briefly represent eastern, central and western study sites, respectively.

Ilam (26°55′ N, 87°54′ E, 1300 m., a. s. l.) : Annual mean temperature is 18.9℃ with 1250 mm of total annual rainfall. Highest precipitation (78%) is received during summer.

Kathmandu (27°44′ N, 85°24′ E, 1320 m., a. s. l.) : Annual mean temperature is 18.1℃. Annual amount of rainfall is 1364 mm. Summer season receives highest rainfall (80% of the total).

Jumla (29°17′ N, 82°10′ E, 2300 m., a. s. l.) : Annual mean temperature is 12.3℃. Annual precipitation is 769 mm only. Precipitation during July and August is about 48% of the total annual rainfall (Climatic data : Jackson 1987).

### Methods of Field Survey

The survey was carried out in 40×40 m plots in all the sites. The stems bigger than 4.5 cm in diameter only were counted as trees and diameter measurement was made at 1.3 m height (Yoda 1967; Richard 1980). Tree height was measured by hypsometer. Relevant ecological information like altitude, exposure, inclination, etc. were recorded in the field. Natural as well as semi-natural forest stands were chosen for the study. The survey was carried out between 1983 to 1990 at different seasons (Suke Pokhari, Deurali and Phulchoki-Autumn; Shivapuri-Spring; Chotra and Chankhali Lekh-Summer).

Table 1. Floristic composition of *Quercus semecarpifolia* forests represented by density (D ; no/ha) and basal area (BA : % of land area)

| Locality | Suke Pokhari | | Deurali | | Shivapuri | | Phulchoki | | Chotra | | Chankheli Lekh | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Altitude (m) | 2600 | | 2410 | | 2600 | | 2650 | | 3090 | | 3260 | |
| Exposure | S/E | | S | | E | | S/w | | N/W | | N/E | |
| Gradient (°) | 35 | | 30 | | 30 | | 30 | | 10 | | 35 | |
| Species name | D | BA | D | BA | D | BA | D | BA | D | BA | D | BA |
| First layer (height) | (21-35m) | | (20.1-24m) | | (19.5-28m) | | (19-28m) | | (18-28m) | | (19-27m) | |
| *Quercus semecarpifolia* | 75.00 | 0.5077 | 43.75 | 0.2329 | 75.00 | 0.5803 | 75.00 | 0.4249 | 93.75 | 0.3177 | 68.75 | 0.5129 |
| *Q. lamellosa* | — | — | 18.75 | 0.0455 | — | — | — | — | — | — | — | — |
| *Abies spectabilis* | — | — | — | — | — | — | — | — | 6.25 | 0.0111 | — | — |
| Subtotal | 75.00 | 0.5077 | 62.50 | 0.2784 | 75.00 | 0.5803 | 75.00 | 0.4249 | 100.00 | 0.3288 | 68.75 | 0.5129 |
| Second layer (height) | (up to 21m) | | (12—20m) | | (13.5—19m) | | (11.5—19m) | | (up to 17.5m) | | (up to 19m) | |
| *Quercus semecarpifolia* | 12.50 | 0.0418 | 75.00 | 0.1826 | 56.25 | 0.1441 | 31.25 | 0.1081 | 118.75 | 0.1289 | 6.25 | 0.0037 |
| *Lithocarpus pachypylla* | 25.00 | 0.2040 | — | — | — | — | — | — | — | — | — | — |
| *Dodecadenia grandiflora* | 6.25 | 0.0179 | — | — | — | — | — | — | — | — | — | — |
| *Q. lamellosa* | — | — | 37.50 | 0.0693 | — | — | — | — | — | — | — | — |
| *Q. glauca* | — | — | 6.25 | 0.0254 | — | — | — | — | — | — | — | — |
| *Symplocos* sp.1 | — | — | 18.75 | 0.0185 | — | — | — | — | — | — | — | — |
| *Betula utilis* | — | — | — | — | — | — | — | — | 6.25 | 0.0029 | — | — |
| *Prunus rufa* | — | — | — | — | — | — | — | — | — | — | 12.50 | 0.0037 |
| Subtotal | 43.75 | 0.2637 | 137.50 | 0.2958 | 56.25 | 0.1441 | 31.25 | 0.1081 | 125.00 | 0.1318 | 18.75 | 0.0074 |
| Third layer (height) | | | (up to 12m) | | (up to 13m) | | (up to 11m) | | | | | |
| *Quercus semecarpifolia* | — | — | 25.00 | 0.0253 | — | — | 187.50 | 0.0403 | — | — | — | — |
| *Q. lamellosa* | — | — | 12.50 | 0.0016 | — | — | — | — | — | — | — | — |
| *Q. glauca* | — | — | 6.25 | 0.0207 | — | — | — | — | — | — | — | — |
| *Symplocos* sp.1 | — | — | 25.00 | 0.0069 | — | — | — | — | — | — | — | — |
| *Lyonia ovalifolia* | — | — | 68.75 | 0.0059 | 6.25 | 0.0004 | — | — | — | — | — | — |
| *Symplocos* sp. 2 | — | — | 18.75 | 0.0041 | — | — | — | — | — | — | — | — |
| *Edgeworthia gardeneri* | — | — | 18.75 | 0.0036 | — | — | — | — | — | — | — | — |
| *Elaegnus* sp. | — | — | 12.50 | 0.0008 | — | — | — | — | — | — | — | — |
| *Myrsine semiserrata* | — | — | — | — | 12.50 | 0.0042 | — | — | — | — | — | — |
| *Litsea oblonga* | — | — | — | — | 25.00 | 0.0033 | — | — | — | — | — | — |
| *Berberis wallichii* | — | — | — | — | 12.50 | 0.0032 | — | — | — | — | — | — |
| *Symplocos summuntia* | — | — | — | — | 12.50 | 0.0025 | — | — | — | — | — | — |
| *Berberis* sp. | — | — | — | — | — | — | 25.00 | 0.0012 | — | — | — | — |
| *Machilus odorattisima* | — | — | — | — | — | — | 18.75 | 0.0011 | — | — | — | — |
| *Meliosma dillenifolia* | — | — | — | — | — | — | 6.25 | 0.0011 | — | — | — | — |
| *Euonymus tingens* | — | — | — | — | — | — | 6.25 | 0.0010 | — | — | — | — |
| *Prunus* sp. | — | — | — | — | — | — | 6.25 | 0.0003 | — | — | — | — |
| Subtotal | 0.00 | 0.0000 | 187.50 | 0.0689 | 68.75 | 0.0136 | 250.00 | 0.0451 | 0.00 | 0.0000 | 0.00 | 0.0000 |
| Total | 118.75 | 0.7715 | 387.50 | 0.6435 | 200.00 | 0.7383 | 356.25 | 0.5789 | 225.00 | 0.4607 | 87.50 | 0.5203 |

## Results and Discussion

The results of the studied plots show some variation as the physical feature of the country is extremely complex, nevertheless, they fairly represent the site preference of the species and local climatic condition. Here some of the functional attributes of *Q. semecarpifolia* forest, stratified at different layers, are discussed as shown in Table 1 and Fig. 2 and compared with similar type of studies in other parts of Nepal.

Fig. 2 represents the frequency histogram of DBH of all the trees in the respective forest stands where the share represented by *Q. semecarpifolia* are separated from others. In Deurali L-shaped diagram, with highest frequency in the smallest diameter classes was found. More or lees similar type of diagrams were found in Shivapuri and Phulchoki. While reflecting this structure, high degree of regeneration of *Q. semecarpifolia* trees in the lower layer in Phulchoki and moderate emergence of oaks in Deurali is observed, although oaks are being succeeded by other species in Shivapuri (Table 1). On the other hand trees in smallest diameter classes were lacking or almost lacking in Chankheli Lekh and Suke Pokhari. These plots are characteristic in stratification with no plants in the third layer. Evidences show that such tendency is due to human influence like fuelwood collection, foddering and grazing of domesticated animals whereas other sites are likely to be free from such disturbance. The third layer is also

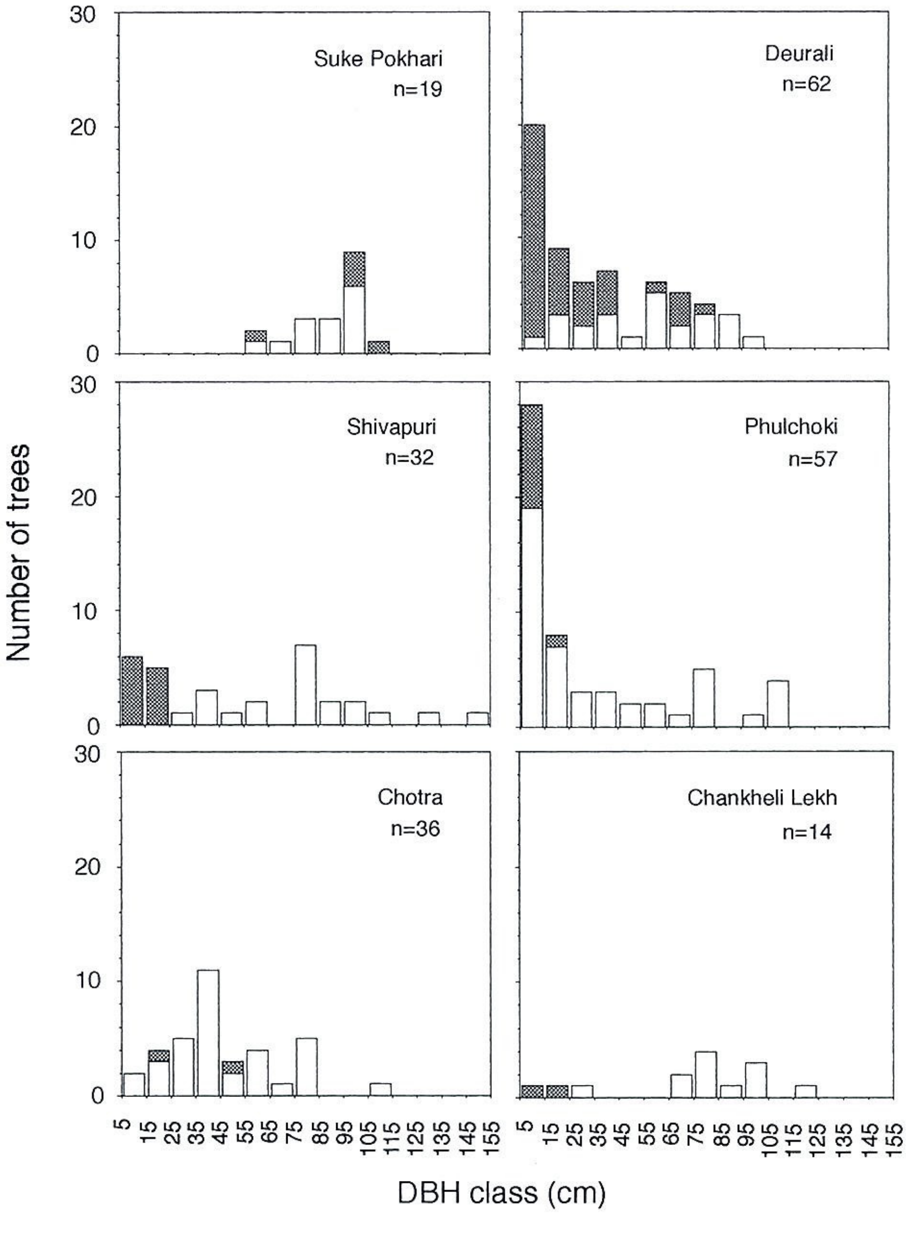


Fig. 2. Frequency histogram of DBH within the surveyed plots. Open part represents *Quercus semecarpifolia* and shaded one other trees.

lacking in Chotra but this stratification is most likely affected by the highest frequency of the trees in the intermediate class. More or less convex type of structure noticed in Chotra suggests the forest developing towards maturity. There is wide gap formation in certain diameter classes in some of the plots which seems to be from periodical disturbances at different phases of forest growth. Comparatively the site of Shivapuri, with maximum record of diameter growth (= 150.56 cm), seems to be in natural or in original condition. But in most of the plots the optimum DBH value is found to be 1 m or slightly more which can be accepted for general purpose.

The total tree density was found as high as 387 (trees/ ha) at Deurali but as low as 87 at Chankheli Lekh. Though the density of the first layer trees is not so different, in general, the total tree density vary significantly from site to site which is mostly governed by the presence of regenerating trees in lower layers. In *Tsuga dumosa-Quercus semecarpifolia* forest the tree density was found to be 220 trees/ha in east Nepal (Junbesi area) by Yoda (1967). Similarly Kanai *et al*. (1975) have found the density of *Quercus semecarpifolia* forest to be 200 and 267 trees/ ha at 2480 and 2450 m in altitude at Phulchoki where the plot size was comparatively small (10×10 m). At the same time they have also reported the density of trees of this type of forest up to 950/ha at similar altitudes in central Nepal. Though there is much variation in density value from site to site it was obvious that this is more significant with the number of mature trees than the total number. The observed variation is probably due to difference in local habitat condition, changes in regional climate and biotic influence.

Basal area percentage covered by the stems bigger than 4.5 cm was found to be highest (0.77%) in case of Suke Pokhari, though the number of trees is less and slightly disturbed. Occurrence of more mature trees have significant contribution to the basal area coverage. The highest value obtained in this forest reflect the favorable growth condition in the east in spite the human impact and despite low tree density. The lowest basal area is exhibited by the forest of Chotra (0.46%) probably due to less mature trees as shown in Fig. 2 though the trees are in moderate density (Table 1). The forest of Shivapuri exhibited a value of 0.73%, which is slightly lower than the optimum value. This forest is in almost undisturbed condition.

The value found in the study plots falls in the medium rank in comparison to other forest types found in Nepal. Ohsawa (1983) has found this value to be 1.05% in *Tsuga dumosa* forest and deciduous forest at 2580 and 2670 m, respectively, in east Nepal. Nakasuga (1972) obtained this value to be 1.18% in *Abies-Rhododendron* forest at Barpak (C. Nepal) and opined that this value as the highest record for the forest in Nepal. Subedi and Shakya (1993), in a study of *Q. semecarpifolia* forest in C. Nepal, found the basal area percentage to be 0.83% in natural but high density plot (1062 trees/ha). Kanai *et al.* (1975) have shown the highest value to be 0.78% and lowest value to be 0.28% for *Q. semecarpifolia* forest in C. Nepal.

As a conclusion it is agreeable that standard, natural forest of *Q. semecarpifolia* has a value of 0.75–0.80% in Nepal.

Though it calls for more repetitive data to generalize these results for wider areas, at the same time it clearly shows the declining trend in the forest quality, especially on high impact areas. It is indicative that further encroachment may lead to serious consequences like loss of bio-diversity, regional instability and imbalance in the ecosystem function. As continued exploitation seems inevitable, strategies for the management has to be ascertained through intensive research for the conservation and rational utilization of this valuable natural resource.

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## References

DMP. 1969. Flora of Phulchoki and Godavari. 144 pp. Department of Medicinal Plants, Ministry of Forests and Soil Conservation, Thapathali, Kathmandu.

DMP. 1986. Flora of Kathmandu Valley. 962 pp. Department of Medicinal Plants, Ministry of Forests and Soil Conservation, Thapathali, Kathmandu.

Jackson, J. K. 1987. Manual of Afforestation in Nepal. 402 pp. Department of Forest, Kathmandu.

Kanai, H., Shakya, P. R. and Shrestha, T. B. 1975. Vegetation survey of central Nepal. *In* Ohashi, H. (ed.): Flora of Eastern Himalaya, Third Report. Univ. Mus., Univ. Tokyo, Bull. No. 8, pp. 415–423. Univ. Tokyo, Tokyo.

Nakasuga, T. 1972. An investigation of forests in Nepal. Res. Bull. Coll. Exp. For. Coll. Agric., Hokkaido Univ., **29**: 155–170.

Ohsawa, M. 1983. Distribution, structure and regeneration of forest communities in eastern Nepal. *In* Numata, M. (ed.) : Structure and Dynamics of Vegetation in Eastern Nepal, pp. 89–120. Laboratory of Ecology, Faculty of Science, Chiba University, Chiba.

Richard, D. 1980. Variations de la structure, de l' architecture et de la biomasse forests du centre Nepal. 161 pp. Ph. D. thesis (3 eme cycle), Universite Scientifique et Medicale de Grenoble, Grenoble.

Stainton, J. D. 1972. Forests of Nepal. 181 pp. John Murray, London.

Subedi, M. N. and Shakya, P. R. 1993. Structure and floristic composition of oak (*Quercus semecarpifolia* Sm.) forest at Domje Chauki, Rasuwa District, Central Nepal. Ind. For. **119**: 466–471.

Wiart, J. 1983. Ecosystemes villageois traditionnels en Himalaya Nepalais: La production forestier suffit-elle aux besoins de la populations. 267 pp. Univ. Scientifique et Medicale de Grenoble, Grenoble.

Yoda, K. 1967. A preliminary survey of forest vegetation of eastern Nepal. J. Coll. Art. Sci., Chiba Univ. **5**: 99–140.

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**マヘンドラ　スベディ：ネパールヒマラヤにおける *Quercus semecarpifolia* Sm. 林の林分構造**

*Quercus semecarpifolia* 林はネパールの温帯の代表的な森林である。この森林の自然的，半自然的林分について直径階分布，個体密度，基底面積を調査した。調査は東部，中部，西部ネパールから各2地点，Suke Pokhari と Deurali, Shirvapuri と Phulchoki, Chotra と Chankheli Lekh を選び，40×40 m の方形区を設定して行った。方形区面積に対する基底面積比は，上記の各地点でそれぞれ 0.77, 0.64, 0.73, 0.57, 0.46, および 0.52% であった。同様に高木の個体密度はヘクタール当たり 118, 387, 200, 356, 225, 87 であった。ネパール各地の類似の森林については，自然林の基底面積比として 0.75–0.80% という値が知られている。成熟林については今後の合理的な利用，劣化した林分については保護が必要である。