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MULTIVARIATE ANALYSIS OF ROADSIDE VEGETATION ALONG MOTORWAY (M-1), PAKISTAN

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Abstract

The present research was undertaken to study vegetation along Motorway (M-1) from Rawalpindi to Attock district (90 km) in Pakistan. Braun-Blanquet's approach was used for the phytosociological survey. Classification techniques like TWINSPAN (Two Way indicator species analysis) and DCA (Detrended Correspondence Analysis) were used to classify the vegetation data. Floristic data was collected from 40 sites at a distance of 10 km on each side of motorway. A total of 45 plant species belonging to 23 families were recorded. TWINSPAN divided the whole flora into two major and fourteen sub-communities. Detrended correspondence analysis (DCA) identifies clusters of species in ordinate space and verifies groups of species identified by TWINSPAN method. A DCA analysis of all the plots maintained a coherency with vegetation types identified by TWINSPAN. This survey based study provides baseline knowledge regarding roadside vegetation and would be helpful in future for Conservation of biodiversity along the road verges and improvement of road verges of M-1.

Introduction

Roads are the major means of communication among the different cities for trade and economy, in order to compete with the International positions (Harper, 2001). Therefore, the construction and maintenance of roads are considered to be necessary in the context of the economical, political and social development of the country (Dierkes & Geiger, 1999). Roads may act as habitats, as linear corridors or as barriers to the dispersal of animal and plant species (Angold, 1997). Road verges comprise the diverse ecological and environmental conditions. Road verges can support habitats and species of nature conservation value. Some areas are specially designated for their biodiversity. The advantage of road sides for study of vegetation performance is now widely acknowledged (Wilson *et al*., 1992). Some parts of the world particularly, Europe, New Zealand, and North America designated the roadsides as excellent habitats for the examination of vegetation. Small marginal habitats in the rural landscape may play an important role for plant species richness as refugias (Sara, 2006). They provide important corridors for the movement of species, and sometimes support plant and animal communities which are important in their own right (Jesse *et al*., 2008). Ahmad (2007) highlighted the importance of wild medicinal plants along road side verges (M-2) Pakistan.

Survey of road verges along M-1, motorway (Rwp-Attock) was conducted to elucidate the distribution of herbaceous flora, their major communities formulated due to ordination classification. M-1 is connecting Punjab and Khyber PakhtonKhawa, Pakistan. The total length of M-1 is 175 km out of which 67 km lies in Punjab and the remaining 108 km in Khyber PakhtonKhawa. (www.pakistaniat.com/2007). This study will provide baseline knowledge regarding roadside vegetation and would be helpful in future for conservation of biodiversity along the road verges of motorways and improvement of road verges.

Materials and Methods

Selection sites: Quadrats were used systematically at regular intervals of 9 kms on both sides of motorway. During site selection the disrupted study area was not taken into account. A range of common vegetation species were collected with entire number of 182 species (45 species individually) from 40 quadrats.

Zonation of road verges: A site normally comprised of two zones:

Zone 1

Border zone: The road shoulder adjacent to the edge of the road sealing. Soil is comparatively affected by traffic.

Zone 2

Verge zone: The fence zone which was demarcated from the adjacent private or state owned land by fence.

Size of quadrats: A suitable size of quadrat is necessary for vegetation sampling. It is selected according to the size and spacing of plants. Vegetation comprised of herbs and shrubs along the roads as quadrat size of 1x 2 m^2 was used on both zones. A total of 40 quadrats were laid down. Within each quadrat the vascular plants and their vegetation cover was noted in each quadrat on each road verge using the Cover estimation (Kent & Coker, 1992). Sampling was done during the months from January to May; 2008. During this period the soil is naturally dry and mostly free of moisture content. Vegetation was also in bloom when plants were in flowering.

Multivariate analysis: To classify vegetation and for applying the ordination techniques multivariate analysis was carried out. Two-Way Indicator Species Analysis (TWINSPAN) was used for the classification of vegetation data which identified the different vegetation groups of definite vegetation. To investigate the relationship among the vegetation types DCA (Deterended correspondence analysis) was conducted.

Results

Vegetation profile of M-1: A total of 45 vascular plants species belonging to 23 families were recorded. Out of 45 species only 15 species occurred with a frequency of more

than 9 %. The roadside vegetation in the study area was dominated by *Carthamus oxycantha, Cynodon dactylon, Calotropis procera, Chrysopogan aucherii, Heteropogon contortus, Lepidium apetalum* and *Conyza canadensis*. These species therefore are identified as dominant and leading species of roadsides in both qualitative and quantitative terms. Besides the above-mentioned species, other species, which occur quite frequently, are *Conyza banariensis, Prosopis cinerarea, Avena sativa, Sorghum halepense, Cymbopogan jwarancusa, Medicago polymorpha, Euphorbia helioscopia, Dalbergia sisso* etc.

Classification of roadside vegetation

TWINSPAN classification: To classify the vegetation types, a cluster analysis (Classification algorithm) was conducted by TWINSPAN. On the basis of analysis, 14 main vegetation types were identified. These results were presented in a dendogram (Fig. 1). Results shown by TWINSPAN indicated that the vegetation of the whole study area was divided into two major communities with further division of 14 sub-communities.

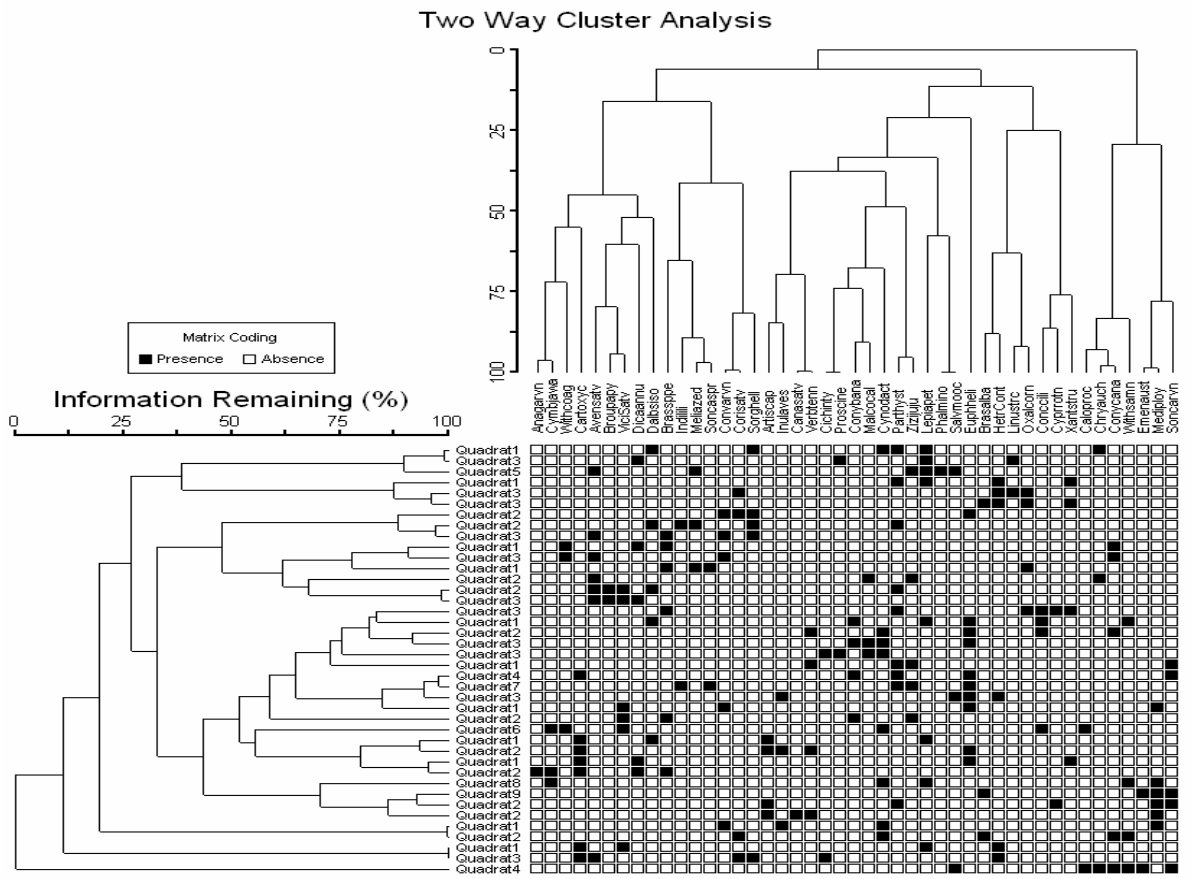

Fig. 1. TWINSPAN classification of species along M-1.

Major community 1: *Lepidium apetalum and Carthamus oxycantha.*

Major community 2: *Euphorbia helioscopia* and *Parthenium hysterophorus.*

Sub-communities are:

1.1: *Hetropogan contortus, Dicanthium annulatum* and *Sorgham hellepense.*

1.2: *Lepidium apetalum, Carthamus oxycantha* and *Avena sativa.*

2.1: *Pathenium hysterophorus* and *Convolvulus arvensis.*

2.2: *Euphorbia helioscopia* and *Cynodon dactylon.*

1. *Lepidium apetalum and Carthamus oxycantha*: *Lepidium apetalum* and *Carthamus oxycantha,* group developed on the shoulder of the road i.e., mostly in the border zone near the road. This group occurs in many quadrats, but the exclusive species exhibits a fairly good cover values e.g., *Carthamus oxycantha* 54.6% and *Lepidium apetalum* 37.28%. This group mostly comprises of herbaceous flora including *Salvia moocraftiana, Indigofera linifolia, Artemisia scoparia* etc.

Other major communities clustered by TWINSPAN in the first group comprising a rich population of *Hetropogon contortus, Dicanthium annulatum, Sorghum hellepense, Lepidium apetalum, Dalbergia sisso, Carthamus oxycantha, Avena sativa* and *Oxalis corniculata* being most dominant species on the borders and fences on both sides of roads.

2. *Euphorbia helioscopia* and *Parthenium hysterophorus*: *Euphorbia helioscopia* and *Parthenium hysterophorus* were covering the most part on the road verges and beyond the borders till the fence area. It was making a major group as a whole. Motorway provided a vast area or habitat to the herbs and shrubs to be grown to make the high vegetation cover on motorway. Traffic pollution is effecting the rapid growth of species. Other species were *Carthamus oxycantha, Lepidium apetalum, Cymbopogan jawarancusa, Euphorbia helioscopia, Cynodon dactylon* etc.

In other sub-communities present were of *Euphorbia helioscopia* being most dominant species. *Parthenium hysterophorus* the second most abundant species on the road of M-1.Other species in this community includes *Convolvulus arvensis* and *Cynodon dactylon.*

Detrended correspondence analysis (DCA) classification: From the DCA (Detrended correspondence analysis) cluster of species in ordination space was identified. The result showed four communities. The major groups were named after the dominant species as:

Group-1: *Carthamus oxycantha, Lepidium apetalum, Parthenium hysterophorus and Euphorbia helioscopia* community.

Group-2: *Conyza canadensis, Calotrpis procera and Crysopogan aucheri* community.

Group-3: *Cymbopogan jawarancusa, Conyza banariences* and community.

Group-4: *Cynodon dactylon, Sonchus arvensis, Prosopis cinerarea* community.

1. *Carthamus oxycantha, Lepidium apetalum, Parthenium hysterophorus* and *Euphorbia helioscopia* community: This community having *Carthamus oxycantha, Lepidium apetalum, Parthenium hysterophorus* and *Euphorbia helioscopia* grows on the shoulder of road, on heavily compacted manmade soils, which contains sands and gravel in the soil surface. This community can be regarded as trampled community.

The diagnostic species identified in this group were *Carthamus oxycantha, Lepidium apetalum, Parthenium hysterophorus* and *Euphorbia helioscopia*. They showed cover value 54.6%, 37.28%, 14.5% and 26.1% respectively. The other species *Sonchus apser* and *Dalbergia sisso,* also exhibited some dominance in the study area with the cover value of 30.8%. This group is comprised of 13 species. On the basis of high percentage of occurrence and cover value of *Carthamus oxycantha* and *Lepidium apetalum,* this group can be distinguished from other groups of the vegetation.

2. *Conyza canadensis, Calotrpis procera* and *Crysopogan aucheri* community: This community carrying very vast area on the road verges on motorway. The community was rich in species. *Conyza canadensis, Calotropis procera* also called as white weed is spread on vast area on road sides. *Crysopogan aucheri* community was situated along the entire area.

Other species which dominated this community were *Withania coagulens* with 19.33% cover in the community. *Conyza canadensis* with 36.4%, *Calotrpis procera* with 50% cover recorded in study area. Minor species include *Broussonetia papyrifera* with 34.5% and *Vicia sativa* with 13.83% recorded in study area.

3. *Cymbopogan jawarancusa, Conyza banariences* and *Conclus ciliaria* community: This community was situated on the flat-sloped area of the road side. *Cymbopogan jawarancusa* and *Conyza baariences* being most dominant species in this community making vegetation cover of 31% and 34.15%. This community has no diagnostic species. Other species which play a minor role in increasing the population in this community were *Ziziphus jujulea* 12.6%, *Brassica alba* 13.5% and *Anagalis arvensis* 7%. Herbaceous stratum of *Cymbopogan jawarancusa* was well developed.

4. *Cynodon dactylon, Sonchus arvensis, Prosopis cinerarea* community: *Cynodon dactylon* was most diagnostic species identified in this community with a cover of about 33.12%. *Medicago polymorpha* and *Cynodon dactylon* were the most dominant grasses present there. A total of 5 species were recorded in this community. *Malcomia calulica* 22%, *Cichorium intybus* 22.25%, *Prosopis cinerarea* 32.5% and *Sonchus arvensis* 18.8% were observed in this part of area.

Discussion

The present study was carried out to investigate the floristic composition of roadside vegetation in Rawalpindi to Attock motorway. Floristic data was collected along the motorway and different methods of quantization were applied for best interpretation. In present work an attempt has been made to describe the vegetation types and their distribution on M-1. Two Way Indicator Species Analysis divided the whole flora into two major groups in which *Lepidium apetalum* and *Euphorbia helioscopia* were abundant among all species. These groups were sub-cortical deep white matter divided in to other comunnities.Group1 was divided having abundance of *Hetropogon contortus, Dicanthum annulatum and Carthamus oxycantha* etc. While the second group was divided and abundant species like *Cynodon dactylon* and *Parthenium hysterophorus* were seen in abundance similarly. In a similar study TWINSPAN analysis yielded 18 vegetation groups that comprised 7 main vegetation types in Egypt (Abd-El-Ghani, 2005).While in the present research 14 vegetation groups were noted on motorway. Similar studies were conducted by Ahmad & Hussain (2008), along the road verges of Kallar Kahar area of salt range and Ahmad *et al.,* (2009) along road verges of Abbottabad city.

Vegetation data was also analyzed with DECORANA (Detrended Correspondence Analysis). The results were in cluster shaped groups. The vegetation along motorway was divided into 4 major groups in order of clustering, coexistence and allopathic activity. In another similar study cluster of species were identified with DCA resulting in verification of four communities (Ahmad, 2010). Overall group 1 with abundance of *Carthamus oxycantha* the most dominant species in respect of DCA technique. The second and third group

with *Conyza banariensis* and *Cymbopogan jawarancusa* being most abundant (Fig. 2). Finally the last group showed the maximum population of *Cynodon dactylon*. DCA analysis conducted in Egypt showed relationship of species along coastal roads of Egypt (Abd-El-Ghani, 2005). Hansen & Jansen (1972) while studying the vegetation on roadsides in Denmark also recorded such high frequency of dominating species. Similarly Ahmad *et al*., (2010) while investigating the vegetation flora along the hard shoulders of M-1 in Pakistan recorded the same results. Heindl & Ullmann (1991), Ali *et al.*, (2004) also recorded high cover value of *Cynodon dactylon* and described it as a species, which restrain the expansion of other flora. Disturbance frequently helped in the spread of invasive exotic plants (Larson, 2003 and Arevalo *et al*., 2005) and the existence of *Parthenium hysterophorus* among vegetation cover.

In present study along motorway (M-1) it is concluded that roadside vegetation cover and floristic diversity can be used to preserve the local flora also local species be planted in order to avoid the exotic species being introduced into the area inadvertently. Further more studies should be carried out to preserve and enhance the conservation status.

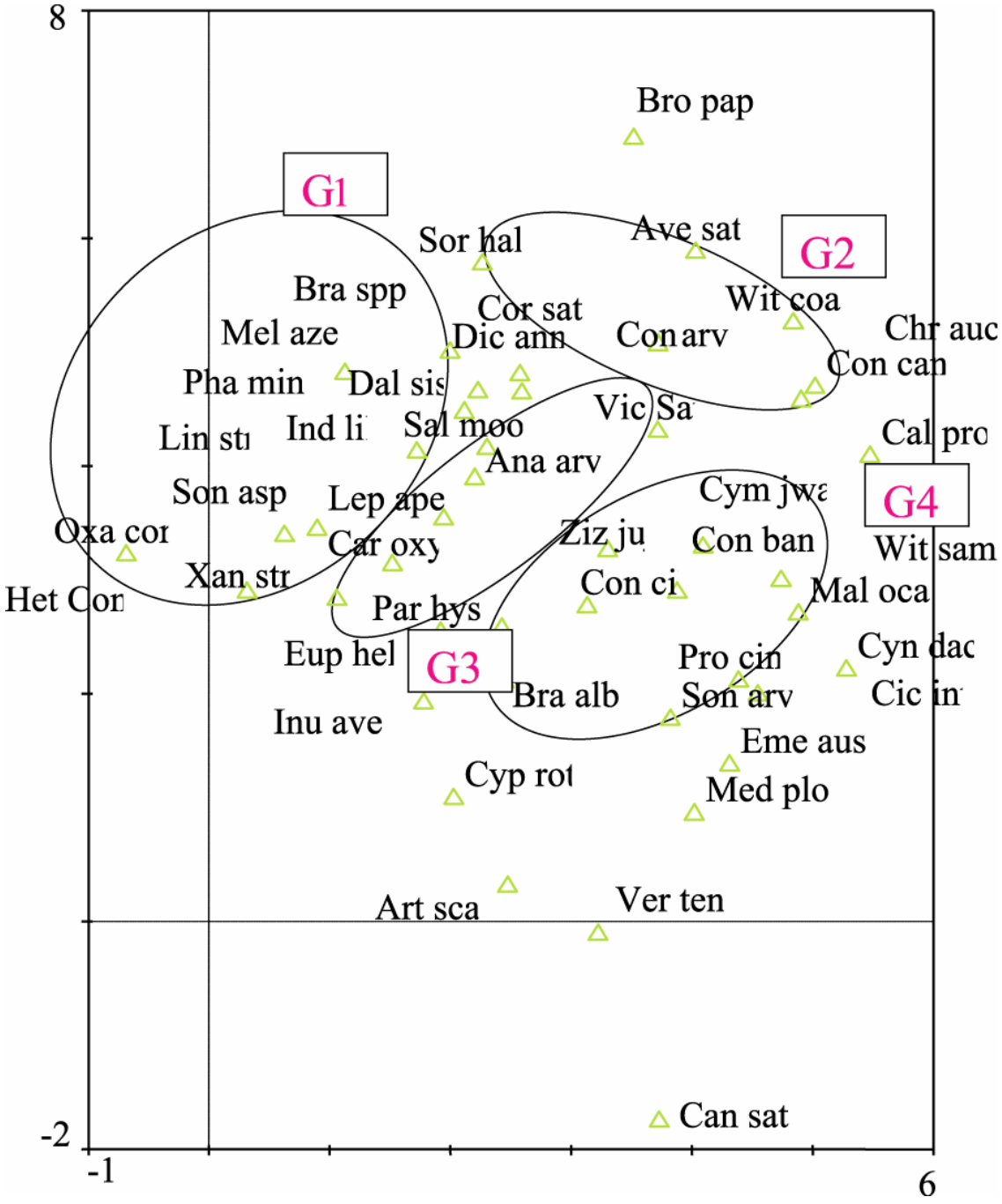

Fig. 2. Classification of vegetation on M-1 with DCA (Detrended Correspondence Analysis)

References

Abd-El-Ghani, M.M. and N.A. El-Sawaf. 2005. The coastal roadside vegetation and environmental gradients in the arid lands of Egypt. *Community Ecology*, 6: 143-154.

Ahmad, S.S. 2007. Medicinal wild plants from Lahore-Islamabad Motorway (M-2). *Pak. J. Bot.*, 39(2): 355-375.

Ahmad, S.S. 2010. Detrended Correspondence Analysis of vegetation along Motorway (M-2), Pakistan. *Pak. J. Bot.*, 42(4): 2473-2477.

Ahmad, S.S. and S.Z. Hussain. 2008. Ethno medicinal survey of plants from salt range (Kallar Kahar) of Pakistan. *Pak. J. Bot*., 40(30): 1005-1011.

Ahmad, S.S., A. Wahid and K.F. Akbar. 2010. Multivariate classification and data analysis of vegetation along Motorway (M-2), Pakistan. *Pak. J. Bot.*, 42(2): 1173-1185.

Ahmad, S.S., S. Fazal, E.E. Waleem and I.Zafar.2009. Elevation of ecological aspects of roadside vegetation around Havailian city using multivariate techniques. *Pak. J. Bot.*, 41(1): 461-466.

Ali, M., T. Ahmad and A. Rashid. 2004. Phytosociological synthesis as inferred from soil: analysis of some industrial areas of Punjab. *Asian Journal of Plant Sciences*, 3: 320-324.

Angold, P.G. 1997. The impact of a road upon heathlands vegetation: effects in plants species composition. *J. Applied Ecology*, 34: 409-417.

Arevalo, J.R., J.D. Delgado, R. Otto, A. Naranjo, M. Salas and J.M. Fernandez-Palacios. 2005. Distribution of alien vs. plant species in roadside communities along an altitudinal gradient in Tenerife and Gran Canaria (Canary Island). *Perspectives in Plant Ecology, Evolution and Systematics.* 7: 185-202.

Dierkes, C. and W.F. Geiger. 1999. Pollution retention capabilities of roadside soils. *Water Science and Technology*, 39: 201-208.

Hansen, K. and J. Jansen. 1972. The vegetation of roadsides in Denmark. *Dansk. Bot. Arki.*, 28: 1-59.

Harper, D. 2001. Horseboating (Web). The Horseboating Society. Retrieved on April 9, 2007.

Heindl, B. and I. Ullmann. 1991. Roadside vegetation in Mediterranean France. *Phytocoenologia*, 20: 111-141.

Jesse, M.K., J.M. Suzanne and A.M. Melodie. 2008. Road verges as invasion corridors? A spatial hierarchical test in an arid ecosystem. *Landscape Ecology*, Online article.

Kent, M. and P. Coker.1992. *Vegetation description and analysis*, 1st ed. Belhaven Press, London.

Larson, D.L. 2003. Native weeds and exotic plants relationship to disturbance in mixed-grass prairie. *Plant Ecology*. 169: 317-333.

Sara, A. 2006. Plant species richness in midfield islets and road verges-The effect of landscape fragmentation. *Biological Conservation*, 127(40): 500-509.

Wilson, J.B., G.L. Rapson, M.T. Sykes, A.J. Watkins and P.A Williams. 1992. Distribution and some climatic correlations of some exotic species along roadsides in New Zealand. *J. Biogeography*, 19: 183-194.

Websites:

http://pakistaniat.com/2007/11/11/peshawar-islamabad-motorway-m1-is-now-open-for- traffic/

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