

## CALCICOLOUS ASSOCIATIONS OF THE BOMBAY STATE\*)

(with 5 tables)

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In the present investigation, we have surveyed the calcicolous associations of Neral which is 56 miles south of Bombay; Khandala and Lonavala which are only 6 miles apart from each other and 76 and 82 miles south of Bombay respectively; the other two are hills, Matheran and Purandhar. Matheran is approachable from Neral by rail and road and is 56 miles from Bombay and Purandhar is 152 miles S.E. of Bombay and is approachable via Poona.

At the outset it may be mentioned that all these associations are purely seasonal and occur only during the monsoon. After October all the plants constituting them dry up except a few perennials like *Blumea membranacea* DC., *Lindenbergia urticaefolia* LINK & OTTO., *Tridax procumbens* LINN. and *Kickxia ramosissima* BOISS.

The associations are found generally on the walls which are built either of stone or rocks cemented together with lime-mortar or mud. Some of the walls are fairly new and are built with cement-mortar which contains a high percentage of calcium carbonate. We have also come across a few brick walls held together either by lime-mortar or more crudely with mud and cow dung. This aspect of the old and new walls is important since the former are more thickly covered with vegetation and are generally dominated by *Adiantum lunulatum* BURM. and give a better idea of plant succession.

Whatever the type of wall, its composition, in so far as the binding material is concerned, bears an amount of calcium either in the form of calcium carbonate or as exchangeable calcium, which is not usually found in the ordinary plant substratum. The calcium carbonate content varies on an average from 4.90 to 59.19% and its exchangeable calcium content varies from 22.89 to 73.92 m.e. per 100 gms. of the soil. The total replaceable bases range from 34.5 to 89.2 m.e. per 100 gms. of the soil. Therefore, these soils are more than 100 percent saturated with calcium and hence, both from the calcium carbonate and the available calcium point of view, the associations found on them can be designated as calcicolous.

Since the above four associations are all dominated by four different species of the same genus, *Arthraxon*, we have named them after their dominant and their most characteristic species. Thus we distinguish four associations of *Arthraxon lancifolius* HOCHST., *Arthraxon quartinianns* NASH., *Arthraxon inermis* HOOK., and *Arthraxon Purandharensis* BHARUCHA.

Table 1. Height in ft. above sea-level, the annual rainfall in inches and the annual maximum, minimum and mean temperature in °F.

Localities	Height in ft.	Rainfall in inches	Temperature °F		
			Max.	Min.	Mean.
Bombay	Sea-level	70.5"	86.0	74.9	80.4
Khandala	1787'	187.89"	—	—	—
Lonavala	2208'	170.08	—	—	—
Matheran	2650'	208.58	77.7	67.3	72.5
Purandhar	4472'	Approx. 50"	—	—	69.7

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It is curious that in the Bombay state i.e. in a region of heavy rainfall ranging from 50" to 208" (Table 1) the most characteristic associations of the walls should be dominated by one genus (*Arthraxon*) of grass. We are thus able to distinguish the four associations of *Arthraxon* not only by the altitude at which they occur but also by the amount of rainfall.

The four associations are classed in the order *Adiantetalia lunulatae*. Whereas we are able to group the last three associations in one alliance of *Lecanthion peduncularae*, the first association of *Arthraxon lancifolius* HOCHST. cannot, for the present, be placed into any alliance. Further study of similar associations might reveal to us the missing alliance.

From the first column of the Tables it will be seen that 70% of the plants of the associations are therophytes, 28% are chaemaphytes and 2% are hemi-cryptophytes. Hence all these associations are therophytic. This is supported by the fact mentioned earlier that all of them are purely seasonal.

In order not to make the Tables too long we have omitted the companion species from them.

Below are given the descriptions of the four associations:

#### I. ARTHRAXOETUM LANCIFOLII BHARUCHA OR THE ASSOCIATION OF ARTHRAXON LANCIFOLIUS HOCHST. AND ELATOSTEMA CUNEATUM WIGHT OF BOMBAY AND NERAL.

From Table 2 and the text, it will be seen that the association is not very rich and contains only 41 species, half of which occur only three times, plus species which occur less than three times in the 39 relevés so far studied. This paucity in the number of species is explicable on the fact that the soil contains very high amounts of calcium carbonate, ranging up to 60%. The soils are alkaline in nature with pH varying from 7.2 to 8.8 which is not correlated with the calcium carbonate-content.

As will be seen from the same Table, the association is found on walls varying in height from 3 to 40 ft. on any exposure. Those walls which are well exposed to sunlight show profuse growth of *Achyranthes aspera* LINN., *Cleome viscosa* LINN. and *Arthraxon lancifolius* HOCHST. whereas on shaded walls, *Adiantum lunulatum* BRUM. is found growing profusely.

Many of the walls during the monsoon are covered with a thick mat of moss, terrestrial algae and liverworts, which form the primary stages of plant succession. Very often *Adiantum lunulatum* spreads itself on such walls.

*Elatostema cuneatum* is also found at higher levels at Khandala-Lonavala but occurs locally and is restricted generally to the bottom of old walls, and hence is not found in the *Arthraxon quartinianus*-association. On the other hand it is found with *Arthraxon lancifolius*-association only.

A very interesting point may be noted here namely that another genus closely related to *Elatostema* is also found in a similar habitat at Khandala, Lonavala, Matheran and Purandhar namely *Lecanthus peduncularis* WEDD. Both belong to the same natural order *Urticaceae* and were formerly grouped in the same genus. Whereas *Lecanthus* is found fairly abundantly on the walls of the last four places and is evenly distributed, *Elatostema* is confined to very old, well-shaded walls. It was recorded by WOODROW in 1907 as occurring at Mahim and Thana near Bombay on old walls. Since then it seems to have disappeared at Mahim and was recorded by BHARUCHA on a very old wall at Sion, near Bombay. We have located this plant on a number of very old walls at Sion and Kurla in considerable quantity. This peculiar distribution on particular types of old walls indicates that this species probably requires accumulation of humus for its growth and it would be interesting to trace its distribution and habitat outside the Bombay State.

The second characteristic exclusive species of the association namely *Lindenbergia urticaefolia* is a species which is also confined to the walls where *Arthraxon lancifolius* is found. There are two species of *Lindenbergia* found in India according to COOKE and they are *L. polyantha* ROYLE. and *L. urticaefolia* LINK & OTTO. MISRA and SHIVA RAO conclude on morphological grounds and analytical data that these two species are probably ecotypes of the same species. BLATTER has stated that there are 18 varieties of *Lindenbergia urticaefolia*. In our studies we have come across four varieties, each distinct from the other in their morphological features. Since, however, these differences are very little we have classified them all under *Lindenbergia urticaefolia* for the present.

*Kickxia ramosissima* JANCHEN. is a delicate straggler found on the walls of the Bassein Fort in association with *Lindenbergia urticaefolia* but it has not been observed in any of the other areas of our studies. In Purandhar another species of *Kickxia* namely *K. incana* grows abundantly on the fort walls. SANTAPAU regards the plants found at Bassein and Purandhar as belonging to the genus *Kickxia* and not *Linaria* as mentioned by COOKE.

*Adiantum lunulatum* is found both on calcareous and non-calcareous walls and also two forms of the species are found, one with big leaves and the other with small leaves and runners. It is very probable that what we at present group under one species may be two varieties of the same species or two different species.

Of the companion species, three deserve mention and comment. They are *Tridax procumbens* LINN., *Acalypha indica* LINN., and *Euphorbia pilulifera* LINN.

Of the rest of the species grouped under "Companion" many are escapes and as mentioned before are found growing in the surrounding areas. Of these species, the most common ones which regularly occur on the walls are *Apluda varia* var. *aristata* HACK., *Commelina benghalensis* FORSK., *Achyranthes aspera* LINN. and *Pilea microphylla* LIEBM. Except the first, the rest are all common weeds. *Apluda varia* occurs generally only on those walls where *Lindenbergia* is found. This grass which attains luxuriance on the walls, also occurs in other associations and in forests. Hence it cannot be regarded as a highly calcicolous species.

## II. ARTHRAXOETUM QUARTINIANII BHARUCHA OR THE ASSOCIATION OF ARTHRAXON QUARTINIANUS NASH AND RHYNCOGLOSSUM OBLIQUUM BLUME OF KHANDALA-LONAVALA.

The second association is found at Khandala and Lonavala which is named after the dominant species, *Arthraxon quartinianus* and its highly exclusive characteristic species, *Rhyncoglossum obliquum*.

It is interesting to note that another species of the genus *Arthraxon* namely *Arthraxon Meeboldii* STAPP. occurs in this association in considerable number. However, it has been observed that it prefers sunnier aspects and is found more often on the top of the walls along with *Ischaemum rugosum* SALISB.

Several of the species found in this association are differentials of altitude and climate. These are *Tripogon capillatus* JAUB & SPACH., *Cardamine hirsuta* HOOK., *Plectranthus incanus* LINK., *Oldenlandia corymbosa* LINN., *Athyrium bobenckerianum* BEDD., *Impatiens Kleinii* WIGHT & ARNOLD. and *Senecio Grabami* HOOK. The other species of the above mentioned genera are to be found in the association of *Arthraxon purandharensis* and will be discussed later.

From Tables 4 and 5 it will be seen that this association is allied to *A. purandharensis* of Purandhar and *A. inermis* of Matheran by three species namely *Arundinella tenella* NEES & WIGHT., *Lecanthus peduncularis* WEDD. and *Gymnogramme calomelanos* KAULF.

From the same Table it will be seen that different species of the association thrive on different types of walls. It will be observed that the exclusive species like *Rhyncoglossum*

*obliquum* and the species of alliance, *Lecanthus peduncularis* develop luxuriantly on the mud walls which are moist whereas *Arthraxon quartinnianus* and *Arundinella tenella* thrive well on the lime walls.

It is also interesting to note that several species of this association are found in abundance on the roofs of the houses and on tree tops like *Justicia simplex* DON., *Senecio Grabami* HOOK., *Garnotia arborum* STAFF., *Cyanotis papilionacea* SCHULT., *Pleopeltis membranacea* BEDD.,

### III. ARTHRAXOETUM INERMI BHARUCHA OR THE ASSOCIATION OF ARTHRAXON INERMIS HOOK. AND BEGONIA CONCANENSIS DC. OF MATHERAN.

The third association is named after its dominant species, *Arthraxon inermis* and its exclusively characteristic species, *Begonia Concanensis*. It contains about 31 species including ferns and bryophytes.

This association is more closely allied to the *Arthraxon quartinnianus* association than to the association of *Arthraxon purandharensis*.

*Arundinella tenella*, *Lecanthus peduncularis* and *Gymnogramme calomelanos* are the species of alliance of these three associations. Besides the associations of *Arthroetum quartinnianii* and the *Arthroetum inermis* are characterised by the presence of three species of alliance, namely *Athyrium hobenackerianum*, *Pleopeltis membranacea*, and the *Utricularia striatula* Sm. These three species are found in equal density at Matheran as well as at Khandala-Lonavala.

As has already been mentioned, Matheran is a region of heavy rainfall and receives about 208.5" per annum, about 84.22" of which falls in the month of July itself. It is by the middle of August and the beginning of September that the walls become covered with vegetation, usually of various types of moss, bryophytes, and species of *Selaginella* representing the primary stages of succession. This stage is immediately followed by *Utricularia striatula*, *Lecanthus peduncularis* and *Begonia concanensis* while *Arthraxon inermis* makes its appearance as the last stage.

Even in its companion species, this association seems to resemble *Arthraxon quartinnianus* association very closely.

*Paracaryum coelestinum* BTH. is found both at Khandala and Lonavala. It is interesting to note that while *Paracaryum coelestinum* is found at these places, its allied species *Adelacaryum coelestinum* BRAND occurs in the association of *Arthraoxetum purandharensis*.

*Cardamine hirsuta* DALZ. is yet another species fairly common to the associations of *Arthraoxetum inermis* and *Arthraoxetum quartinniani* whereas *Cardamine trichocarpa* HOCHST., an endemic of Western India, occurs on the Purandhar Fort.

### IV. ARTHRAXOETUM PURANDHARENSIS BHARUCHA OR THE ASSOCIATION OF ARTHRAXON PURANDHARENSIS BHARUCHA AND NEPETA HINDUSTHANA DALZ. OF PURANDHAR.

The present association is named after its dominant species *Arthraxon purandbarensis* BHARUCHA and its highly exclusive characteristic species *Nepeta Hindusthana* DALZ.

Of the four calcareous associations studied this is the most interesting from many points of view. The first and most important feature is the new species of *Arthraxon* which we have provisionally named "purandharensis" after the name of the Maratha fort on which it is found. This species differs from all the rest by being the largest and is allied to *A. Meeboldii* but differs from it in so many respects that we have provisionally created it into a new species. It will be described shortly elsewhere.

The second interesting point that arises out of the study of this association is that it has got nine species endemic to Western India and it would not be surprising if the new species of *Arthraxon* proves also to be one of them. The reason for the richness of this association in endemics is probably to be found in the isolated position of the Fort in the Deccan. It is probable that the association of other forts of the Deccan like Shivgadh, Raigadh, Sinhgadh, Malhargadh and others may also show high percentage of endemics; for example, *Arthraxon jubatus* HACK is said to be found on the Kori Fort 12 miles south-west of Lonavala and *Arthraxon serrulatus* HOCHST. at Kamalgadh and the Belgaum Forts in the Karnatak. Hence the future study will be directed on the plant associations of the fort Walls of the past Maratha Empire.

The third interesting point of this association is that species of more than six genera differentiate this association from those of Khandala-Lonavala, Matheran and Bombay. For example *Tripogon Jacquemontii* Stapf., *Athyrium salcatum* BEDD., *Oldenlandia aspera* DC., *Senecio Edgeworthii* HOOK., *Plectranthus Stocksii* HOOK., *Cyanotis fasciculata* SCHULT., and *Impatiens dalzelli* HOOK. are found only at Purandhar, whereas *Tripogon capillatus* JAUB & SPACH, *Athyrium Hobenackerianum* BEDD., *Oldenlandia corymbosa* LINN., *Senecio Grabaami* HOOK., *Plectranthus incanus* LINK., *Cyanotis axillaris* SCHULT. and *Impatiens Kleinii* WIGHT & ARNOLD. are found at Khandala-Lonavala and Matheran. Whereas *Kickxia incana* BOISS. is found at Purandhar, *Kickxia ramosissima* JANCHEN. is found at Bombay. The presence of so many distinct differential species proves without doubt that all these are indicators of altitude and climate.

Further study of Table 5 will show that even the companion species of these two associations of Khandala-Lonavala and Purandhar differ from each other.

Of the exclusive characteristic species, the following are endemic namely *Senecio Edgeworthii*, HOOK., *Plectranthus Stocksii* HOOK., *Nepeta Hindusthana* DALZ., *Cardamine trichocarpa* HOCHST., *Lamprachenium microcephalum* BTH., *Cyanotis fasciculata* SCHULT., *Impatiens Dalzelli* HOOK., *Pimpinella monvica* DALZ., and *Adelacaryum coelestinum* BRAND. Among these *Nepeta Hindusthana* is the highly exclusive characteristic one.

The association is allied to the two associations of *A. inermis* and *A. quarantinianus* by three species namely *Arundinella tenella* NESS & WIGHT., *Lecanthus peduncularis* WEDD. and *Gymnogramme calomelanos* KAULF. Of these three species, the most interesting is *Lecanthus peduncularis* WEDD., because of its allied genus *Elatostema cuneatum* WIGHT. as described earlier. Like *Elatostema cuneatum*, *Lecanthus peduncularis* is generally found on shady and moist walls and preferably at the base. *Arundinella tenella* next to *Arthraxon* is the most abundant grass. *Gymnogramme calomelanos* as seen from Tables 3, 4 and 5 is found very few times.

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