these enzymes. Comparison of the favoured conformations of penicillin with that of clavulanic acid indicates that the relative orientations of the bicyclic ring system and the orientation of the carboxyl group of the former are very similar to the latter when the thiazolidine ring is in the C_3 puckered conformation (Table I and Fig. 4). This suggests that for optimal binding with β-lactamases the thiazolidine ring of penicillin should assume a conformation in region II (C_3 puckered form). As pointed out in our earlier papers[2,3], to bind with transpeptidase also the thiazolidine ring should assume a similar conformation. As mentioned already, in solution, the population of this conformation will be small for penicillin compared to clavulanic acid since the latter favours only one type of conformation. This may explain the competitive inhibitory property of clavulanic acid.

Experimental studies indicate that the rate of hydrolysis of the lactam peptide bond by β-lactamases is very slow in clavulanic acid compared to that in penicillin. It is not clear at this stage whether the presence of the aminoacyl group or the flexibility of the five membered ring is required for this reaction to take place.

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OBSERVATION OF HIGHER SEISMICITY ASSOCIATED WITH LOWER PREMONSOON RAINFALL IN NORTH-EAST INDIA

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ABSTRACT

A comparison of the temporal variation of the premonsoon rainfall with that of seismicity for about fifty-five years in North–Eastern Indian region shows that both premonsoon rainfall and seismicity in the same year are inversely related to each other. However, heavy premonsoon rain seems to occur a year or so before every earthquake of m gnitude seven or greater. Influence of premonsoon rainfall on earthquake occurrence in this region is discussed.

INTRODUCTION

ACCORDING to plate tectonic theory, the N.E. Indian region is marked by underthrusting of the Indian plate to the north and Burmese plate to the east and south-east. The region has the highest seismicity compared to the rest of the country. The region is also characterised by high rainfall especially during monsoon (June to September). Since more than 50% of the earthquakes of this region having magnitudes greater than seven ($M > 7$) occurred during the first half of the monsoon season, it is suspected that premonsoon rainfall may have some influence on the occurrence of earthquake in this region. If some relation between the two phenomena can be found, it will be a very convenient method for prediction of earthquakes in the North-East India by observing only the variation of premonsoon rainfall.

Data

The earthquake data have been taken from Tandon *et al.*[1]. The number of earthquakes for a particular year is taken to be the total of the earthquakes that occurred from 1st June of that year until 31st May of the next year, assuming that premonsoon rainfall determines the seismicity of the next 12 months. The premonsoon rainfall data have been obtained from Indian Meteorology Department, Poona. Average rainfall of four widely separated stations such as Dibrugarh, Dhubri, Silchar and Haflong has been taken as representative rainfall values for the entire N.E. India for seismicity comparison.

Results and Discussion

Figure 1 shows the simultaneous plots of premonsoon rainfall variations from 1915 to 1969, and variation of the number of earthquakes ($M \geqslant 5$) per 12 months during 1915–1970 in N.E. India. Leaving fluctuations of one year out of consideration, the less than average rainfall periods are 1916–20, 1921–24, 1930–33, 1935–40, 1944–46, 1949–51, and 1959–69.

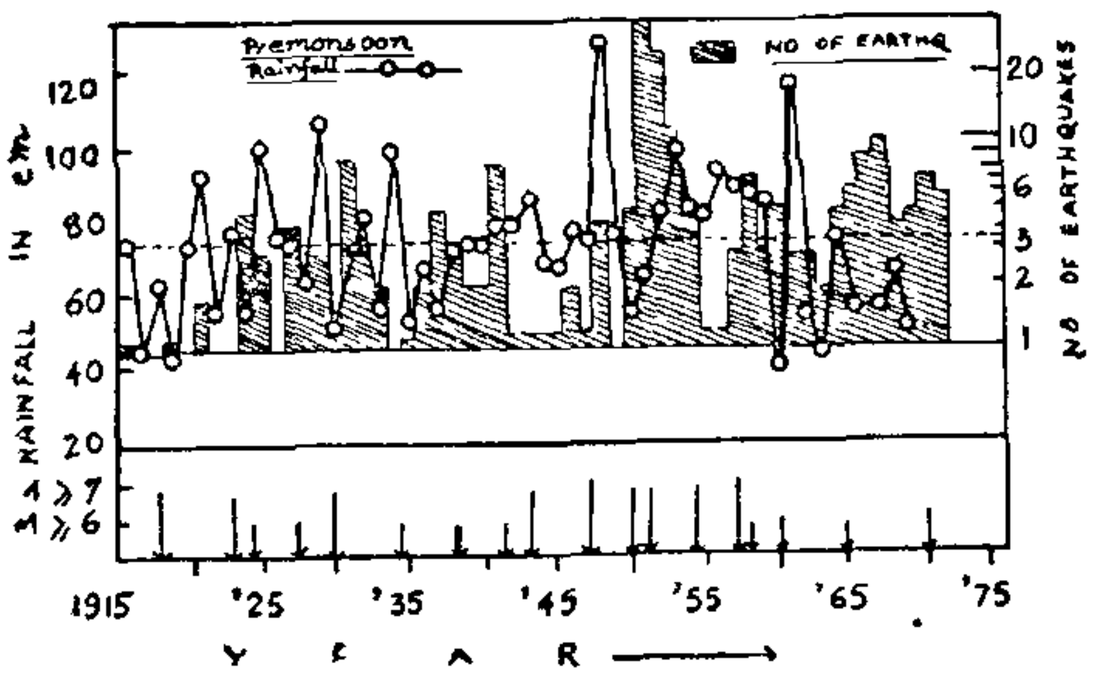

FIG. 1. Variation of premonsoon rainfall and seismicity in N.E. Indian region with time. Seismicity is represented by the number of earthquakes per 12 months from 1st June to 31st May next year, having $M \geqslant 5$. Arrows represent the years of occurrence of earthquakes having magnitudes $M \geqslant 6$. The dashed line represents average premonsoon rain for the years under consideration.

These periods are associated with high seismicity. In fact, nearly all earthquakes of magnitudes greater than seven of this region occurred in the relatively low rainfall year or years. The rainfall peaks in the years such as 1915, 1921, 1925, 1929, 1934, 1948 and 1961 are associated with relatively low seismic activities. Even earthquakes with $6 < M \leqslant 7$ seem to show similar relationship with premonsoon rainfall. Thus there is association of higher seismicity with low premonsoon rain or premonsoon "drought" in N.E. India. However, heavy premonsoon rain seems to occur about a year or so before every earthquake of magnitude seven or greater.

The number of earthquakes that occurred during premonsoon (March–May), Monsoon (June–September), and postmonsoon (October–February) periods were compared with the corresponding rainfall during those periods. But the correlations were poor. Similarly, comparisons of 12 month seismicity with annual, post-monsoon and monsoon rainfall did not show any better correlation.

The heavy premonsoon rain before the occurrence of earthquakes of magnitude seven or greater seems to be significant. The excess fluid pressure as triggering mechanism suggested by Nur[2] may be applicable here also. Scanty rainfall during postmonsoon period (winter) leaves the land dry. Water from heavy rains during premonsoon period may penetrate into permeable fractures and trigger earthquakes, similar to those reported from Japan[3]. The time delay between heavy rain and earthquake occurrence may be due to the complex process of fluid migration to the focal region and triggering. The subsequent monsoon rain may, in some way, influence the process.

Since the predominant focal mechanism of the earthquakes of this region is thrust-fault type[4,5], lower premonsoon rain coupled with evaporation loss from the top layers of the ground, amounts to the reduction of vertical load. Reduction of vertical load as a triggering mechanism in thrust-fault type ea thquakes has been reported by Fletcher and Sykes[6].

The facts and mechanism cited above, at least qualitatively, tend to indicate that heavy premonsoon rain before and lower premonsoon rain during the year of occurrence may be a sequence of events leading to the triggering of earthquakes in the N.E. India. The problem requires detailed examination.

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