

## Old black gum (*Nyssa sylvatica*), the longest tree-ring chronology in New Hampshire, USA

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### Introduction

The geographic range of *Nyssa sylvatica* var *sylvatica* (blackgum, tupelo, pepperidge) covers most of the eastern US, with populations concentrated in the Southeast. New England populations are at the northern end of the range and are often disjunct by many miles. In the Southeast *Nyssa* typically grows on uplands and alluvial stream bottoms, as opposed to the closely related *Nyssa sylvatica* var. *biflora* (swamp tupelo) which is limited to Coastal Plain coves and swamps. At its northern extremity *N. sylvatica* is found downslope in poorly drained acidic habitats, such as Sphagnum-filled glacial depressions with red maple, red spruce, white pine, yellow birch and hemlock (Fowells 1965, Baldwin 1978) and lakeshores.

Most authors consider *Nyssa* to be shade tolerant, on par with red maple and red spruce (Baldwin 1978). Orwig and Abrams (1994) found *Nyssa* to be a gap-facultative species which can persist in the subcanopy and then release, even after 170 yr. In a study of mid- to late-successional oak stands in Virginia these authors found multiple releases and suppression periods. The major releases coincided with logging in the late 1800's and early 1900's, whereas the more frequent moderate releases were not well synchronized and reflected local gap dynamics.

*Nyssa* is insect pollinated, and its fruits (1 cm drupes) are dispersed by birds and flowing water. Cloning by root sprouts leads to a somewhat clumped distribution of stems on the landscape, on a scale of several meters. The wood is considered poor lumber, because the spiral interlocked grain causes severe warping when the lumber dries (Zebryk 1991). The wood is diffuse porous and the rings are not easy to distinguish, especially in the sapwood.

The main goal of this study was to develop the first well-replicated, tree-ring chronology from *Nyssa sylvatica*. Previous information available to us indicates that *Nyssa sylvatica* is a long-lived species which could reach more than 500 years. However, the nature of *Nyssa* wood anatomy (diffuse porous) makes tree-ring dating sometimes problematic.

## Study sites

Mature *Nyssa* trees were sampled at sites in Deerfield and Nottingham Townships, Rockingham County, New Hampshire, midway between Portsmouth and Manchester NH. At the first site beavers created an impoundment, leaving large dead *Nyssa* snags standing or fallen in several feet of water. We cut disc cross-sections from six snags. The beaver pond was about 700 m long, and apparently took several years to fill, because tree deaths near the dam dated to 1990 and near the shallow upper end dated to 1993. For the remaining sites we chose 3 of 16 shallow undrained basins in glacial till, which are typically contain up to 3' of woody fibrous peat of the Balch unit (SCS, 1959). These forested swamps have a Sphagnum groundcover and an abundant fern understory. Large *Nyssa* trees (60 - 70 cm DBH ) dominated the canopy, with hemlock, red maple, and white pine in the subcanopy. In basins B9, B12 and B13 a total of 21 *Nyssa* and 3 hemlocks were sampled with an increment borer, with 2 to 4 cores per tree, spaced 180 to 90 degrees apart.

## Sample preparation and processing

Two methods were used to mount increment cores. In the first (standard) method we glued the cores into a routed channel in 1 x 1 cm wooden mounting sticks. The cores were sanded flat and finished with 600# sandpaper. We viewed the cores with reflected light under a binocular microscope at 8-40x, and measured the ring widths with a Measu-Chron measuring bench with a precision of 0.01 mm. In the second method we prepared the core as a sandwich between two mounting sticks. A specially constructed thickness planer was used to plane the sandwich to a thickness of 1 mm, so that the core could be viewed with transmitted light on the microscope stage. A drop of glycerin was applied to increase ring contrast. The disk cross-sections were sanded with belt and random orbital sanders to 600# and measured with reflected light. All series were cross-dated with program COFECHA (Holmes et al 1983) to check the consistency of ring measurements between series.

Fifteen series were measured from 11 trees. The series exhibited an overall between-series correlation of 0.56, which compares quite favorably with that of conifers commonly used for climate reconstructions. We found that the planed cores using transmitted light were less readable than the standard cores using reflected light, although this method has worked with other diffuse porous species such as birch, maple and poplar (Krusic and Hornbeck 1984). Our *Nyssa* chronology dated to 1434, which is the oldest chronology in New England, to the best of our knowledge.

## Chronology development

We used program ARSTAN (Cook and Holmes 1986) for developing the chronologies. Program ARSTAN produces two types of chronologies: standard and residual chronologies. The Standard chronology was developed by averaging all the samples in the chronology by removing the non-climatic components present in tree-ring series. The residual chronology was produced in a similar way but using residual from autoregressive modeling. The tree-ring series were

standardized using a conservative procedure to maintain in the series as much low variance as possible. Only negative exponential of line regression curves were used for removing the non-climatic signals.

The chronology covers the interval 1434-1995 (562 years) and includes 15 radii from 10 trees. Replication is low in the early part of the chronology (1434-1527), where less than 6 samples per year are included. Correlation between trees (Y Variance, Fritts 1976) is  $r = 0.321$  and  $r = 0.441$  for the standard and residual chronologies, respectively. The autocorrelation in the standard chronology appears to be relative higher in relation to other broadleaf species. The first order autocorrelation is 0.72, which may respond to the swampy environments in which black gum grows in New Hampshire. During the 1714-1995 common interval for most of the samples (10 radii) the variance associated with the first eigenvector is 38.3 and 49.6 for the standard and residual chronologies, respectively. When compared with other trees growing in wet sites, these values of variance in the first eigenvector are substantially higher.

### **Climate correlation**

The relationship between tree growth and climate was evaluated using the program PRECON (Fritts 1991). We used a 16 month climatic window to determine the most significant temperature and precipitation parameters associated with tree growth during the previous and current growing seasons. Correlation and response functions show that July temperature during the current growing season is the climatic variable most strongly related with tree growth. Using the 1892-1985 climatic records from Durham meteorological station, we found that the correlation between tree growth and July temperature is  $r = 0.345$  ( $p < 0.01$ ). Precipitation late in spring (May) is also related to tree-growth in black gum.

### **Preliminary July temperature reconstruction for New Hampshire**

Based on the relationships between black gum growth and climate we developed a preliminary reconstruction of July temperature. To account for the autocorrelation in the tree-ring series we used the standard chronology in the year  $t$  and  $t+1$  to predict the temperature variations at Durham, New Hampshire. For the interval 1892-1985 (93 years) tree-rings explain 22% of the total variance in July temperature ( $r = 0.48$ ). Although these values are not substantially high, these preliminary exercise shows the high potentiality of black gum for climatic reconstructions. The reconstruction captures well the low-frequency variation in the temperature record, particularly the trend in increase temperature from 1920 to the 1960's.

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12NS01A

12NS01B

12NS01D

12NS07B

13NS06A

13NS06D

13NS07B

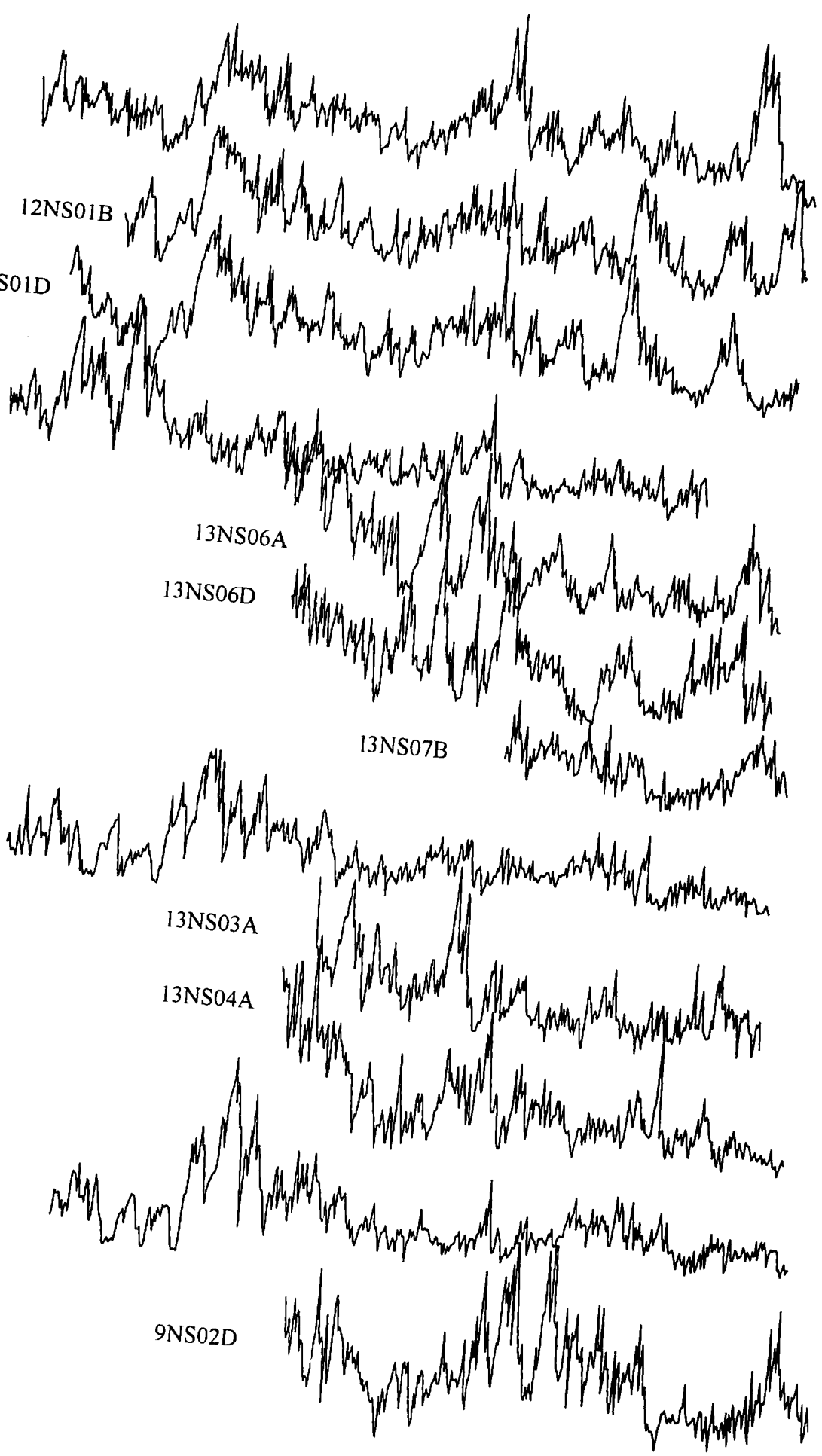
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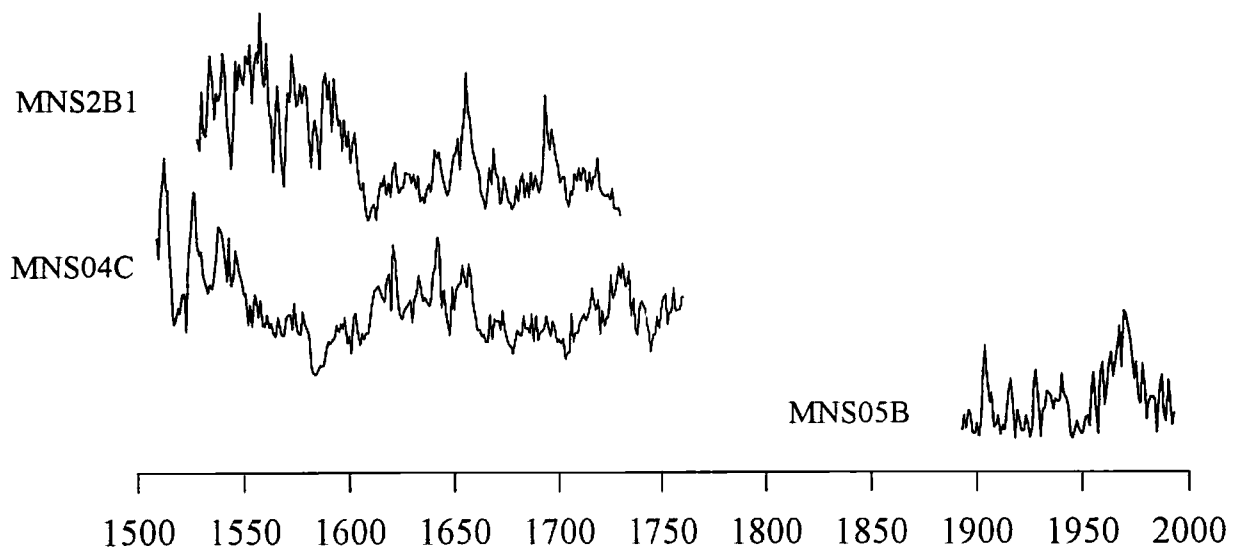
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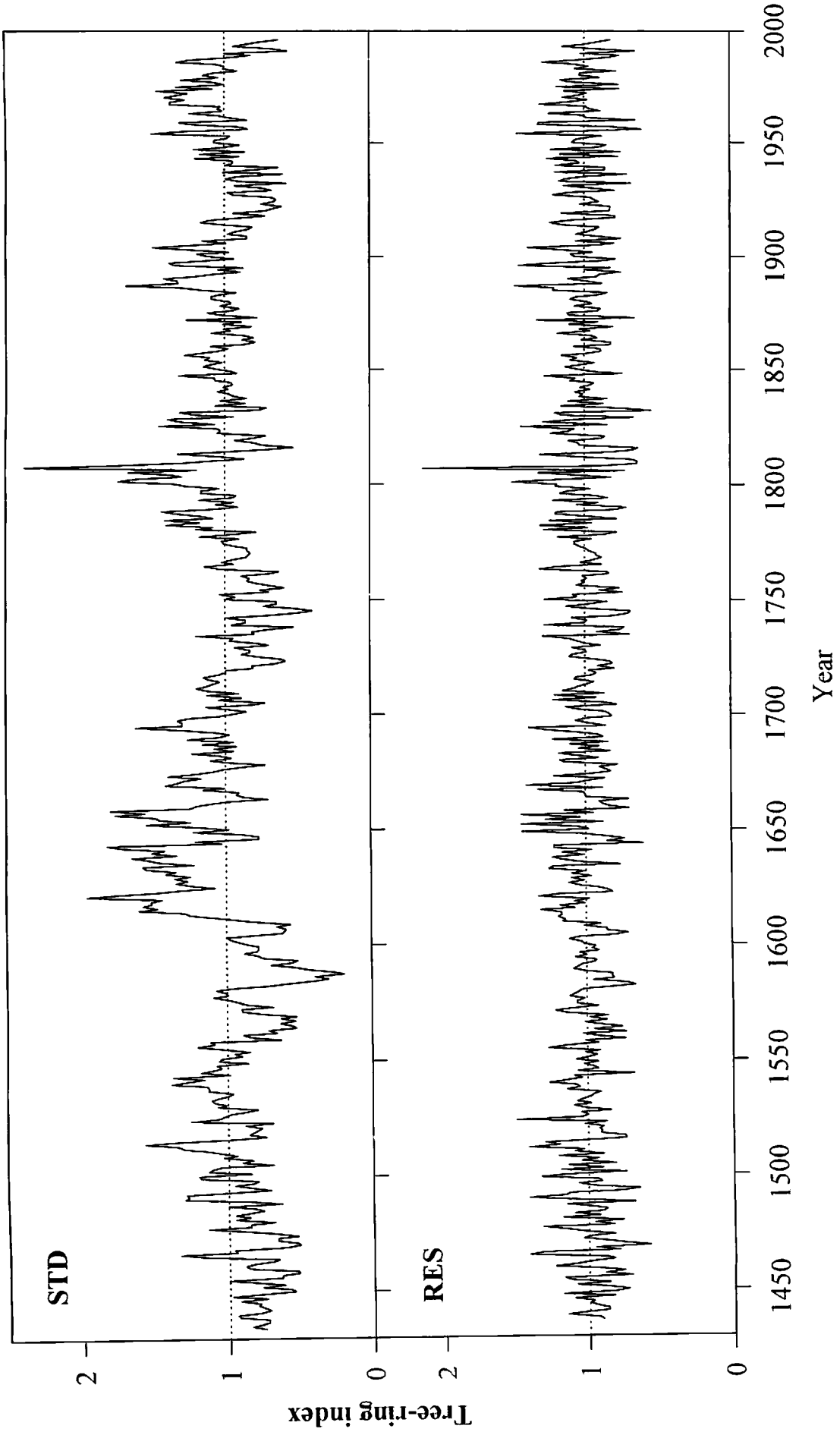
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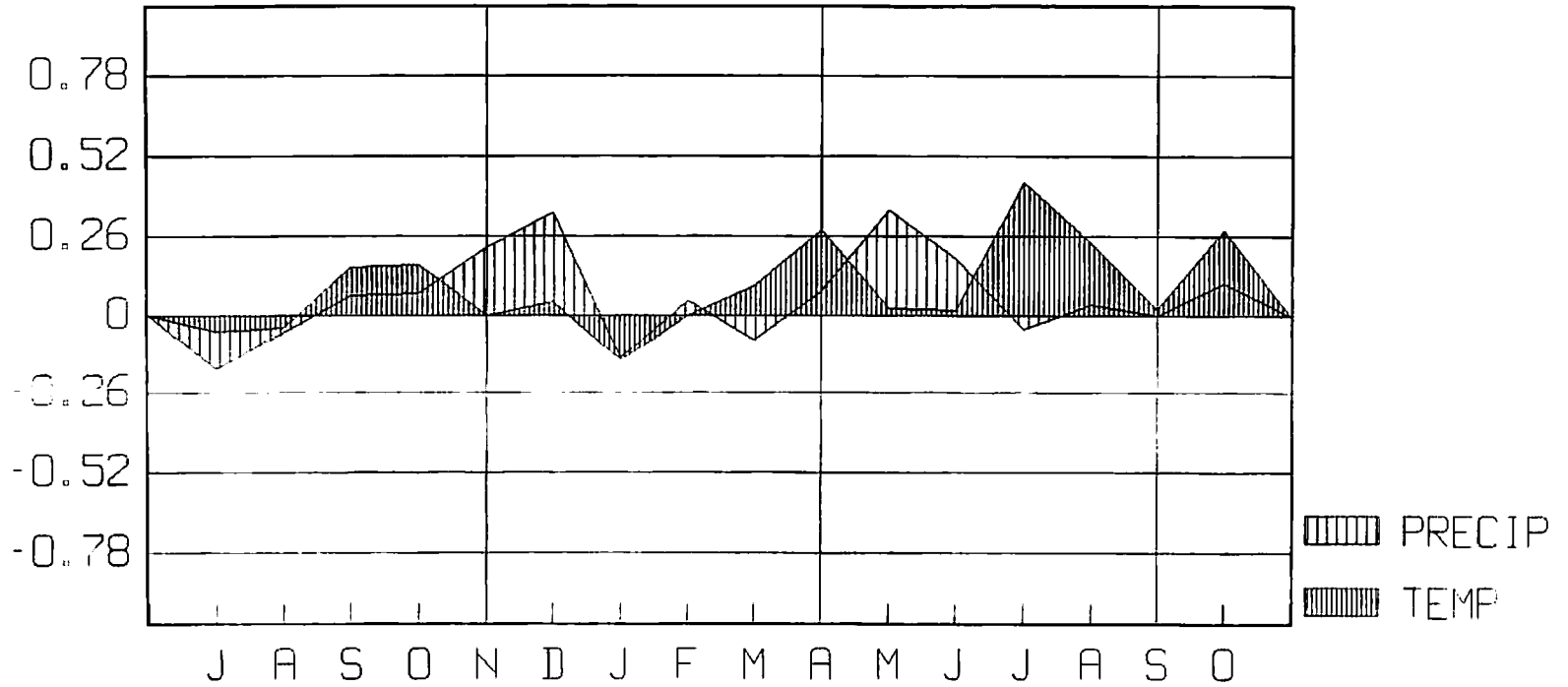






masarsXB durhaXXXp durhaXXXt DIV: 0  
ITRD, TEM & PRE, 1926-1985  
FOR JUL - OCT, N: 60  
SIG SIMPLE R: .260

CORRELATIONS



NUMBER 1, 16 MONTHS, JUL-OCT

MASARSXB DURHAXXP DURHAXXT DIV: 0  
 TEM & PRE, 1895-1985 ,JUL-OCT, N= 91  
 50 REP, Rd: .820+/- .033, Ri: .371+/- .134  
 RSQ: CL= .193, P GRO= .368, TOT= .562

