Pennsylvanian fluvial channels influenced by vegetation in the Joggins Formation, Nova Scotia, Canada

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Riparian vegetation profoundly influences modern fluvial channels, depending on plant life-history strategies, tolerance to disturbance, and habitat drainage. Direct evidence for these dynamic relationships is usually cryptic in ancient deposits. We report evidence for interactions between rivers and in situ vegetation in the Lower Pennsylvanian Joggins Formation based on architectural analysis of channel bodies associated with exposed upright trees. Although this site selection imposes some bias, the case studies encompass fixed, meandering, and distributary channels originally up to 6 m deep, from poorly and well drained settings across a coastal to alluvial plain. Plant groups include lycopsids that preferred stable wetland settings, disturbance-tolerant calamitaleans, and slowgrowing long-lived cordaitaleans.

Our observations suggest that vegetation was effective in stabilizing banks and bars and promoting aggradation. Lycopsids and calamitalean groves colonized the channel bed during periods of reduced flow, and mounds around upright trunks indicate that they nucleated bars after flow resumed. Bank-attached bars with lateral accretion sets contain upright trees, which may have stabilized inclined sediment surfaces, and trees between small distributary channels may have formed vegetated islands. In several cases, lycopsids rooted below the channel base project up into the channel fill and are enclosed in sediment mounds, implying that they survived avulsion and formed obstacles in active channels.

On channel cutbanks, upright lycopsids are tilted towards the channel, and early-formed rhizoconcretions are associated with deep cordaitalean root systems in the tops of channel fills. Both features imply that vegetation contributed to sediment stabilization. The predominance of in situ over transported plant remains suggests that these low flow-strength rivers had limited ability to erode and entrain large woody debris, especially for small channels with strengthened banks.

We infer that patterns of interaction between rivers and vegetation broadly resembled those of today. By the Early Pennsylvanian, rivers had moved from a geomorphic and biogeomorphic mode of operation into a fully ecological mode with prominent feedback loops between vegetation and fluvial processes. Vegetation is commonly poorly preserved in fluvial systems but should be incorporated into facies models for Pennsylvanian and younger formations, possibly also for some Devonian and Mississippian formations.

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