

## Trace fossils are useful — an example from Willapa Bay, Washington

M.K. Gingras<sup>1</sup> and S.G. Pemberton<sup>2</sup>

<sup>1</sup>*Department of Geology, University of New Brunswick, Fredericton, NB E3B 5A3*

<sup>2</sup>*Department of Earth and Atmospheric Sciences, 1-26 E.S.B., University of Alberta, Edmonton, AB T6G 2E3*

Few ichnological paradigms are better accepted than the brackish water model, which has been employed by trace fossil workers for over two decades. Diminutive, low-diversity suites of trace fossils distinguish brackish deposits which are further characterized by distinctive lebenspuren such as *Gyrolithes*, *Teichichnus*, *Planolites*, *Cylindrichnus*, and *Ophiomorpha*. Unfortunately, dividing salinity-stressed trace fossil assemblages into their respective subenvironments is an unresolved problem. However, the delineation of facies in subsurface estuarine-filled incised fluvial systems (IFS) depends on achieving this end.

Willapa Bay, Washington, provides an excellent opportunity to characterize the ichnologic aspects of different subenvironments in IFS. This is due to a well-accepted sedimentologic and stratigraphic framework, which has been developed by Clifton and co-workers. Also, the modern bay provides an analog that can be directly compared to the Pleistocene outcrops, which are well exposed along the bay-margin.

Detailed outcrop studies show that the ichnology of five subenvironments within IFS are distinctive. They are: 1)

muddy intertidal flat deposits, which are typically thoroughly bioturbated by a somewhat diminutive suite of various vertically- and horizontally-oriented shafts and burrows cross cut locally by robust crustacean dwellings; 2) unburrowed to rarely burrowed muddy point bar deposits, which are commonly burrowed by minute *Gyrolithes*, *Skolithos*, *Cylindrichnus*, *Planolites*, *Palaeophycus*, and rare bivalve equilibrichnia. 3) sandy point bar deposits, which are similar to the muddy point bar deposits excepting rare to locally abundant *Ophiomorpha* and a preponderance of *Cylindrichnus*-dominated horizons; 4) well to thoroughly bioturbated bay deposits, burrowed by relatively robust forms of *Ophiomorpha*, *Teichichnus*, *Skolithos* and bivalve equilibrichnia, and; 5) locally bioturbated channel bar deposits, typically displaying robust bivalve equilibrichnia, rare *Ophiomorpha*, and deep-penetrating *Skolithos*. Furthermore, traces from both the modern and ancient deposits display marked reductions in size and diversity in the upper estuary.

Ongoing research at Willapa Bay confirms the validity of the brackish water model and presents data which potentially

improve our understanding of these deposits. For example, vertically oriented deposit feeding structures, caused by mining, stoping, and burrow switching have been shown by many researchers to be common in estuarine deposits:

evidence of these ethologies are present in the Pleistocene record at Willapa Bay and may ultimately help identify ancient IFS.