or a little above low water. But it is seldom found in water of any depth. Exposure to the air between tides appears to be as essential to the vigorous growth of this shell as it would be fatal to the majority of shells. The presence of *M. edulus* in these beds in abundance thus affords evidence of their origin in very shallow water. *Macoma bathica* is also a shallow water species occurring according to Whiteaves "usually at or a little below low water mark." The presence of *Saxicava rugosa* in the fauna has but little significance regarding the depth of water in which the fauna lived since this species is now found living in Canadian waters from low tide level to a depth of 50 feet. Temperature appears to be the chief factor which controls the vertical distribution of this shell. While it is never found in very shallow water in the Gulf of St. Lawrence, in Arctic and sub-Arctic waters it has been found living near low tide level. The association of this cold water-loving shell with such a typically intertidal species as *M. edulus* suggests colder climatic conditions, since water sufficiently shallow to be a satisfactory habitat for *M. edulus* in our present climate would have too high a temperature to accommodate *S. rugosa*.

A noteworthy feature of this fauna is the absence from it of most of the shells which are most common in the fossil fauna found in the widely distributed Pleistocene blue clay. The blue clay fauna represents species which were contemporaneous with the fauna of the sand beds but which occupied a different bathymetric zone—relatively deeper as well as distinctly different in the character of the bottom materials. The species most commonly met with in the clay beds include the following shells: *Portlandica arctica, Saxicava rugosa, Macoma calcarea,* and *Nucula tenuis.*

The collector of fossils is often puzzled by the very marked contrast in the relative abundance of fossils which the same type of sediments display at different localities. While the marine sands may be extremely rich in sea shells at certain localities like the Rideau river sand pits they may at other localities be entirely barren of fossils. One of the reasons for such barren areas is doubtless the tendency of sands to move rapidly under current action and smother the marine life which attempts to live on them. Dr. G. A. Huntsman who has been engaged in studying the conditions under which marine animals live in the Gulf of St. Lawrence has directed attention to another factor in producing lifeless zones. He states*:

"By means of these traps we discovered that a barren zone existed off the Cape Breton shore, comprising the part of the sloping bottom between the depths of 10 and 20 fathoms. In this zone the temperature at the bottom underwent violent fluctuations often in the course of a day or so, at one time being as high as 65° F., and at another as low as 39° F. This was caused by the winds for when the wind was blowing on shore it drove the surface water against the coast and heaped it up, forcing the deeper colder water down, then when it changed and blew off-shore the warm surface water was driven away from the coast and the cold water welled up from below to take its place and so flooded the zone. The effect of this on the slow moving bottom animals may be imagined. Few of them would be able to stand such changes, but the active fishes are able to move up and down the slope and avoid these changes."

*Canadian Fisherman, May, 1917.

It is probable that we can safely ascribe to the variable temperature factor some of the paucity of life which in many places characterizes the Pleistocene clays as well as the sands of the Ottawa valley.

THE INSTABILITY OF SHORE-LINES.

The advance or retreat of shore-lines results from two distinct causes. Elevation or subsidence of the land through the action of deep-seated forces within the earth is a very slowly acting but potent agent in changing geographical features. The second great factor in making new shore lines is the sea itself which is everywhere either cutting away or adding to existing shore lines. The rapidity of this constructive and destructive work of the sea varies enormously according to the hardness of the rocks and the behaviour of waves and currents, as well as the topography of the shore.

Everywhere along the Atlantic coast of America the first named factor has wrought enormous changes in the shore line since the close of the Glacial epoch. A profound subsidence of the land in eastern America which accompanied or followed the disappearance of the glacial ice sheet brought the sea far inland along all the great valleys leading to the sea coast (fig. 2). At one time during this marine invasion it has been estimated that the sea was at least 200 feet deep over Parliament hill. The re-elevation of the land and withdrawal of the sea in eastern Canada and New England was the last great geological event of the Pleistocene epoch.

Elevation or subsidence of the land, although the most powerful factor in producing the major features of coastal geography operates with extreme slowness and is subject to long periods of inactivity, while the sea in revising its boundary never ceases work for a single year. Enormous changes are sometimes wrought in a very short period where the shore line is composed of sand or clay. Sable island off the east coast of Nova Scotia furnishes