Let $\mathcal{F}$ be any family of graphs of bounded treewidth and bounded degree. We construct a quadratic-time algorithm for calculating the genus distribution of the graphs in $\mathcal{F}$, that is, for the number of cellular embeddings in each orientable surface from minimum to maximum genus of $G$. For a given graph $G$ with decomposition tree $T$, we first calculate a partitioned genus distribution for each subgraph induced on the vertices in a node of $T$, and we reassemble the graph $G$ by iteratively amalgamating these subgraphs. With each amalgamation step, we calculate a partitioned genus distribution of the subgraph of $G$ resulting from the amalgamation. Since the number of non-zero values in the genus distribution grows quadratically with the number of vertices, quadratic-time is unimprovable. This result for genus distribution complements an algorithm of Kawarabayashi, Mohar, and Reed for calculating the minimum genus of a graph of bounded treewidth in linear time. (Received September 20, 2011)