Assembly, Structure, and Function of the Export Apparatus of the *Salmonella* SPI-1 T3SSs

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Bacterial type III protein secretion systems inject effector proteins into eukaryotic host cells in order to promote survival and colonization of Gram-negative pathogens and symbionts. Secretion across the bacterial cell envelope and injection into host cells is facilitated by a so-called injectisome. Its small hydrophobic export apparatus components SpaP and SpaR were shown to nucleate assembly of the needle complex and to form the central "cup" substructure of a Salmonella Typhimurium secretion system. However, the *in vivo* placement of these components in the needle complex and their function during the secretion process remained poorly defined. Here we present evidence that a SpaP pentamer forms a 15 Å wide pore and provide a detailed map of SpaP interactions with the export apparatus components SpaQ, SpaR, and SpaS. We further refine the current view of export apparatus assembly, consolidate transmembrane topology models for SpaP and SpaR, and present intimate interactions of the periplasmic domains of SpaP and SpaR with the inner rod protein PrgJ, indicating how export apparatus and needle filament are connected to create a continuous conduit for substrate translocation.