Animal germline cells are specified either through induction or maternal provision, termed also cytoplasmic inheritance. While induction takes place after commencement of the embryonic development (and is therefore termed usually the zygotic induction) and requires cell-to-cell signaling, cytoplasmic inheritance involves rise (evolvement) of a specific, asymmetrically localized oocyte region, termed the germ (pole) plasm. This region contains maternally provided germline determinants (specific mRNAs and proteins) often packed in characteristic electron-dense biocondensates, the germ granules or, alternatively, in less defined accumulations termed “nuage”. Germline determinants are capable of inducing germline fate in a subset of embryonic cells. These cells, termed the primordial germ cells give rise to germ cells of adults – egg cells in females or sperm cells in males. Interpretation of published data in a phylogenetic context indicates that zygotic induction represents the ancestral mode (mechanism) of germline specification, whereas cytoplasmic inheritance evolved secondarily, and independently, in several not closely related animal lineages. Among insects, the cytoplasmic inheritance has been described only in groups nested within Holometabola, i.e. insects undergoing a complete metamorphosis. It has been proposed, in this light, that the cytoplasmic inheritance evolved in the lineage leading to the Holometabola and represents a derived feature of this clade.

On the other hand, the posteriormost ooplasm of some hemimetabolous insects, including various hemipterans (Hemiptera) and bird lice (Phthiraptera) harbors endosymbiotic microorganisms. They invade the ooplasm during advanced oogenesis and are transmitted to the next generation being contained in a specialized compartment of the ooplasm what resembles, to some extent, the transfer of the maternally provided germline determinants from the egg cytoplasm to embryonic cells.

Moreover, classical histological studies as well as our preliminary analyses have shown that in the oocytes of certain hemimetabolans, e.g. thysanopterans (Thysanoptera), psocopterans (Psocoptera), and earwigs (Dermaptera) a specialized, posteriorly located cytoplasm is also present. As to date, bona fide germinal granules have not been found in this cytoplasm, it has been tentatively termed the “pseudo-pole plasm” and interpreted as an intermediate step in the rise of the genuine germ plasm. Our preliminary ultrastructural analyses showed that in earwigs, the pseudo-pole plasm contains both symbiotic microorganisms and cytoplasmic subdomains resembling the nuage. This finding implies functional relationship between the pole plasm and the ooplasm harboring endosymbionts. It is reasonable to hypothesize, in the above context, that the germ plasm is a descendant of the posterior pole ooplasm harboring symbiotic bacteria. This hypothesis will be tested in the proposed project.

The results of the project should shed some light on the fascinating step in the evolution of multicellular animals – the shift from the induction of the germline fate to the acquisition of specialized germ plasm, i.e. evolvement of the cytoplasmic inheritance.