

"AID" never fails

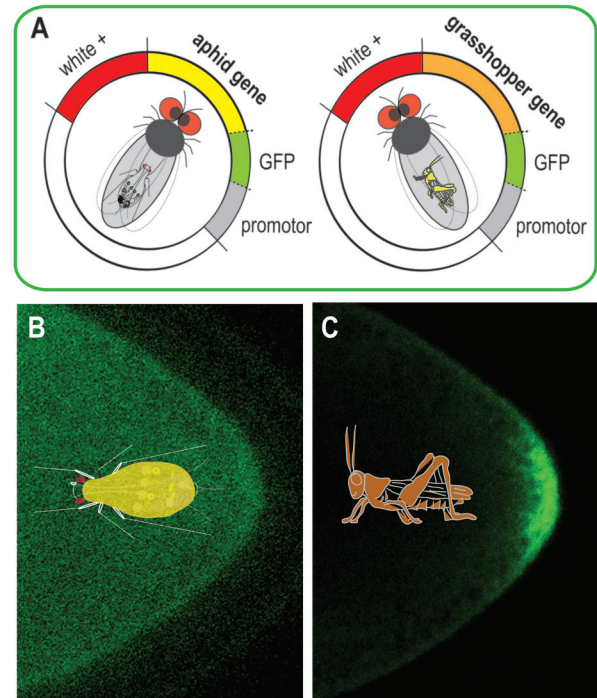
Ectopic expression of aphid genes in fruit flies has led to the discovery of sequences critical to the localization of germline protein Vasa to the germ plasm.

Germ plasm, the cytoplasm of germ cells, is enriched with germline determinants for the development of germ cells. If germ plasm is maternally supplied, it is usually assembled in a subcellular region within the oocyte and then inherited by the newly laid eggs. Soon after cellularization, embryonic cells that incorporate germ plasm will become the primordial germ cells. By contrast, if formation of the germ plasm occurs zygotically after fertilization, synthesis of the germline determinants within a small population of cells is initiated by inductive signals released from neighboring somatic cells. Existing records show that most animals do not possess a maternal germ plasm, and a recent study shows that both mice and crickets use bone morphogenetic protein (BMP) signaling to induce germline specification. This suggests that among animal phyla signal induction is a more prevalent and ancestral mode for germline specification.

Before the identification of a maternal germ plasm in the pea aphid *Acyrtosiphon pisum*, a hemipteran insect belonging to the Hemimetabola, the germplasm-driven mode was regarded as a trait only seen in highly derived insects belonging to the Holometabola. For example, during mid-oogenesis in the fruit fly *Drosophila melanogaster*, *oskar* (*osk*) mRNA and Osk protein are restricted to the posterior pole of the oocyte, acting as "molecular anchors" to restrict the circulation of other germline determinants to the posterior region. Nonetheless, homologous sequences of *osk* cannot be identified in the genome of *A. pisum*, suggesting that it uses non-*osk* molecules to attract other germline determinants to form the germ plasm. Regardless of the presence or absence of *osk* in flies and aphids, the conserved germline marker Vasa (Vas) is specifically localized to the maternal germ plasm of both insects.

To understand whether aphid Vas (ApVas1), like *Drosophila* Vas (DmVas), preserves sequence for being localized by Osk, Professor Chun-che Chang—a developmental geneticist in the De-

AID "Aphid genes expressed in *Drosophila*":
an evo-devo approach for analyzing insect genes in fruit flies



The AID Project. (A) Making constructs for expressing Vas orthologues of aphids (ApVas1) and grasshoppers (SgV) in the fruit fly *Drosophila melanogaster*; (B) ApVas1 protein was evenly distributed in the oocyte; (C) SgV was localized to the oocyte posterior. GFP, green fluorescent protein. (Figure and figure legend: C-c. Chang; Photos: S.C. Wang, G.W. Lin, and M.D. Lin)

partment of Entomology at the National Taiwan University (NTU)—proposed to express ApVas1 in *Drosophila* oocytes. This idea, abbreviated as "AID (aphid genes expressed in *Drosophila*)", was soon approved by Dr. Ming-der Lin, an alumnus of NTU and a junior faculty member working on *Drosophila* oogenesis affiliated with the Department of Molecular Biology and Human Genetics at the Tzu Chi University. The Chang and Lin laboratories collaborated to generate transgenic flies containing the *Apvas1* sequence, aiming to analyze whether ApVas1 could be localized to the germ plasm in the posterior region of the developing oocytes.

Not totally unexpectedly, the expression of ApVas1 was initially detected throughout the *Drosophila* oocytes, indicating that ApVas1 lacks sequences to interact with Osk. Given that both ApVas1 and DmVas are RNA helicases containing conserved DEXDc and HELICc domains, systematic "domain

swapping” experiments were then carried out to pinpoint sequences in DmVas that could direct ApVas1 and DmVas itself to the posterior germplasm. The thorough survey led to a remarkable finding: the HELICc domain of DmVas, either when linked to ApVas1 or alone, was essential for posterior localization; moreover, glutamine (Gln) 527 in the HELICc domain of DmVas was found to be critical for the interaction between Vas and Osk. A residue corresponding to Gln527, which is present in the HELICc domains of grasshopper Vas protein but not in those of aphids, crickets, and mice, may explain why only grasshopper Vas could be restricted to the posterior germ plasm. Published results show that segregation of germ cells in the grasshopper *Schistocerca gregaria* is initiated during mid-embryogenesis via signal induction rather than being driven by a maternal germ plasm, indicating that the conserved Gln527 residue has existed in some insect Vas proteins long before the existence of Osk in *Drosophila*. The results mentioned above have been published in *Scientific Reports*, an open-access online journal from the publishers of Nature, in September 2015.

From the evolutionary and developmental study of insect Vas proteins to the discovery of sequenc-

es indispensable to the interaction with Osk, members of both the Chang and Lin laboratories felt excited by the unpredicted yet fruitful outcome. Their findings shed light on the evolution of germline specification in insects and on Osk/Vas-dependent germ-plasm assembly in *Drosophila*. They expect that the AID project will evolve to facilitate the functional exploration of additional germline and developmental genes in rising insect models with the “aid” of the powerful approaches used in *Drosophila* genetics.

Reference

Szu-Chieh Wang, Hao-Jen Hsu, Gee-way Lin, Ting-Fang Wang, Chun-che Chang and Ming-Der Lin. (2015). Germ plasm localisation of the HELICc of Vasa in *Drosophila*: analysis of domain sufficiency and amino acids critical for localisation. *Scientific Reports*, 5:14703. DOI: 10.1038/srep14703

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New type of powerful photoreceptor provides new possibilities for applications

For approximately 3.5 billion years, solar light has been the main energy source for all life forms on Earth. Therefore, the ability of proteins to capture solar rays and convert them into usable forms of energy is a “natural” development of all living systems.

The Dead Sea is one of the most saline lakes on Earth, and few microorganisms are found in its waters. Among these microorganisms, the haloarchaeon (a salt-loving archaea) *Haloarcula marismortui* survives such harsh conditions by adopting a unique six-rhodopsin system (1). These six rho-

