proteinspotlight
> ONE MONTH, ONE PROTEIN <

Issue 57, April 2005

www.proteinspotlight.org

Flower power

Vivienne Baillie Gerritsen

There is not much we have in common with sweet corn and yet, when you take a closer look at the way an egg cell is fertilised in flowering plants, it is difficult to avoid making comparisons with humans. A long tube – the pollen tube – must make its way into the female gametophyte and release its sperm cells which will then fertilise the egg cell. The great difference however is that a pollen tube has to elongate and travel quite far to perform its business because pollen – unlike sperm – is not mobile. A number of questions arise. What, for instance, guides the pollen tube towards the gametophyte? And how does it know when it has reached it? Scientists have found the beginning of an answer in the form of a small protein: *Zea mays* EGG APPARATUS 1 or ZmEA1, which has a role in pollen tube guidance and orientation in the phases preceding egg cell fertilisation.

Zea mays,

USDA Agricultural Research Service
Keith Weller

Maize has been around for thousands of years. It first appeared in Mexico, where it became an integrated part of their culture. Many tales relate its origins. According to an Aztec myth, men were initially moulded out of clay but lacking a favourable outcome these creations became birds and deer. The second time around, men were whittled out of wood but that too proved fruitless so, on their third attempt, the Gods fashioned men from the dough of maize and mixed it with their own blood to create present day humans. In fact, in Nahuatl – the language spoken by the Aztecs – the word for maize dough is 'toneuhcayotl' meaning 'our flesh'. From the 1500s onwards, the Spaniards participated in distributing it around the rest of the world, which was not a difficult task since sweet corn grows in almost any climate, and at any altitude.

Unless you are a keen botanist, you may need a brief reminder of how flowering plants such as maize (*Zea mays*) are fertilized. In a nutshell, within the female reproductive organ, or ovary, resides the ovule surrounded by tissues. At one end of the ovule are to be found three cells: two synergid cells and the egg cell itself. It is the egg cell which – once fertilized by pollen – will give rise to an embryo and then a new plant. What happens is that a number of pollen tubes migrate towards the ovule but only one will actually enter – by way of a region termed the micropylar opening – and release its sperm cells which will then fertilise the egg cell.

ZmEA1 is a transmembrane protein, barely 94 amino acids long. What scientists have discovered is that its presence is concomitant with the maturing of the egg apparatus and is found both in the synergids and the egg cell itself. It is also found in the region of the micropylar opening just where the pollen tube is supposed to make its appearance. When ZmEA1 is neutralised, pollen tubes migrate towards the ovule but turn away a little

perplexed as though they hadn't found the opening. In wild type maize, several pollen tubes head for the ovule but only one changes direction markedly as it reaches the micropylar opening and actually enters. So it does seem apparent that ZmEA1 has a major role in pollen tube guidance.

No one knows how though. In the beginning of the 20th century, scientists had already assumed that pollen tube guidance had something to do with the egg apparatus. Towards the middle of the century, the existence of chemical substances produced by the synergid cells had been suggested. Almost half a century later, fingers are pointing in the direction of a protein: ZmEA1. Whether ZmEA1 is a signal itself and binds to receptors in a secreted form on the pollen tube tip, or whether it somehow triggers off signals in the tissues surrounding the micropylar opening which in turn bind to receptors on the pollen tube…only time will tell. What is sure is that ZmEA1 is largely expressed in the mature egg apparatus during pollen tube guidance and its expression is halted – and any secreted form rapidly degraded – once fertilisation has taken place thus preventing polyspermy.

Quite a task for such a small polypeptide… Here is a protein which has its say in a plant's fertility and may well be part of the mechanism which provides Nature with the concept of 'species barrier'. If two species are genetically close, say, but cannot produce offspring, one of the reasons could be a difference in pollen tube guidance. Likewise, plant sterility can be addressed more subtly if molecules such as ZmEA1 and their function are better understood.

To what end do scientists undertake such studies? To understand the reproductive process of flowering plants naturally but also to acquire a more subtle view of how sterility can arise in the event of crossbreeding. Maize is the staple diet of many populations. Understanding the fine-tuned processes involved in the 'species barrier' concept could provide the knowledge and wherewithal to cross species which otherwise could not be interbred. In turn, interbreeding new species could help in the fight against famine by providing crops – which are not only sturdy and productive but also nourishing – in countries such as Africa where, still today, 33 million children go to bed hungry every night.

Cross-references to Swiss-Prot

Egg apparatus-1 protein (ZmEA1), *Zea mays* (Maize) : Q5G8Z3

References

1. Marton M.L., Cordts S., Broadhvest J., Dresselhaus T.
   Micropylar pollen tube guidance
   Science 307:573-576(2005)
   PMID: 15681383

2. Salvador R.J.
   Maize
   Iowa State University, Agronomy Department
   http://maize.agron.iastate.edu/maizearticle.html

Protein Spotlight (ISSN 1424-4721), http://www.proteinspotlight.org, is published by the Swiss-Prot group at the Swiss Institute of Bioinformatics (SIB).