



**Comments from the Canadian Biotechnology Action Network (CBAN)
in response to the Notification for a fruit fly for use in recombinant protein
production: EntoEngine from Future Fields
NSN number: 21233**

Submitted to the Science and Technology Branch, Environment and Climate Change Canada
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January 28, 2023

Introduction

Through its “Voluntary public engagement initiative”, the New Substances program of Environment and Climate Change Canada,

“invites stakeholders to share scientific information and test data related to potential risks to the environment or human health from the new living organisms. Information that could be shared to inform the risk assessment process includes:

- environmental fate information
- ecological effects information
- human health effects information or
- exposure information (including sources and routes of exposure)”

And yet the following two paragraphs is the entirety of information provided by ECCC to the public on the “EntoEngine” fruit fly from the company Future Fields.

Activity: The genetically modified *Drosophila melanogaster*, commonly referred to as the “fruit fly”, acts as a living insect bioreactor, capable of expressing recombinant proteins on demand. The line subject to this notification expresses a growth factor protein that is intended for use as a component of cell culture medium for research use.

Genetic modifications: The EntoEngine fly line has been genetically engineered to express a growth factor isolated from cows. Growth factors are the unique cell signaling molecules that play important roles in cell proliferation and development. The gene sequence poses no known risks to either humans or animals. Expression of the gene encoding the growth factor is under the control of a gene expression regulator isolated from yeast. A chromosome stabilizer increases the stability of the line.

This information is clearly insufficient for soliciting public comment and detailed information and analysis on the relevant environmental risk factors in particular.

Overview

The assessment of this GM animal is occurring at the same time that the statute governing this risk assessment, the Canadian Environmental Protection Act, 1999, is under long-awaited review – amendments to it are currently being considered in the House of Commons Standing Committee on the Environment and Sustainable Development. This review includes discussion of possible increased transparency and public engagement including an increased timeframe for public review. (Moreover, the regulations governing the technical aspects of the risk assessment, the *New Substances Notification Regulations (Organisms)*, are also currently being reviewed by Health Canada and ECCC.)

The assessment of this GM fly or any other GM organisms should be halted until the CEPA review is complete.

This is particularly necessary because the current comment process is not transparent and marginalizes public engagement. The New Substance “Voluntary Public Engagement Initiative” (VPEI) of Environment and Climate Change Canada is deeply flawed. CBAN has long critiqued such limited, voluntary federal government “engagement” that invites public comment without providing meaningful information and without real mechanisms for responding to public comments (see, for example, CBAN’s 2012 concerns about the Canadian Food Inspection Agency’s [Biotechnology Notices of Submission Project](#)). Just like the CFIA “Notices of Submission Project”, the VPEI is a voluntary notification system that relies on the cooperation of product developers. This arrangement permits companies to withhold notice of requests for product approval from the Canadian public.

The need for transparency is of the upmost urgency because Health Canada has also recently implemented a “Voluntary Transparency Initiative” in relation to some GM foods and the CFIA is proposing a similar reliance on voluntary corporate reporting in relation to some gene-edited seeds (see our 2022 report “[New Proposals Would Eliminate Transparency on GMOs in Canada](#)”).

In 2021, 105 groups in Canada together called for transparency and government oversight of all genetically engineered foods and seeds (see the November 17 [joint letter](#)). The Canadian public demands transparency on all GMOs and their regulation, across government departments. For example, [a 2015 poll](#) found that, of the 88% of Canadians who said they wanted mandatory labelling, 47% were concerned about government transparency in regulation.

Canadian regulatory agencies should ensure mandatory notification to the public of all GMO submissions for approval.

More fundamentally, there has never been a national public consultation on the use of genetic engineering in our food system, including the creation of GM animals such as this insect. Environment and Climate Change Canada’s experience with the risk assessment of genetically engineered animals is limited to the GM pig “Enviropig”, a range of GM ornamental aquarium fish, and the GM Atlantic salmon from AquaBounty. The GM pig was approved for production by ECCC in 2009 but [never produced because of farmer and consumer objections](#). This example shows the contradiction of resources spent assessing the risks of GM products that are not wanted or needed. (See also [our 2016 recommendations](#) submitted to the House of Commons Standing Committee on Agriculture and Agri-Food.)

Before considering approval of any other GM animals, there should be a process to consult the public on the use of genetic engineering in food and farming.

Exposure

Though we have not been provided with information about the conditions in which the genetically modified (GM or genetically engineered) fruit fly would be produced and the containment plan of the company that would enable us to comment on “sources and routes of exposure,” we nonetheless have critical information about the containment of genetically modified organisms (GMOs) that allows us to conclude there is a risk of escape.

CBAN has documented all the known cases of escape and contamination with living modified organisms in Canada (see our 2019 report [“GM Contamination in Canada: The failure to contain living modified organisms – incidents and impacts”](#) and our 2022 supplemental [“GM Contamination Update: Animals”](#)). Over the almost two and half decades of GM commercialization in Canada, we have observed the escape of a number of GMOs: GM canola, flax, wheat and pigs. The diversity of GMOs that have escaped and the diversity of circumstances illustrates the risk:

- Some escape events occurred with GMOs that were approved by regulators for cultivation (canola and flax), and others were unapproved experimental GE plants and animals (wheat and pigs),
- Escapes were observed from laboratory experiments, field tests, and commercial cultivation.
- Escape incidents occurred with large and small organisms,
- Escapes were due to diverse causes, some of which remain undetermined.

In particular, we bring your attention to two contamination incidents, at two different institutes, with experimental GM pigs:

- In 2002, eleven GM piglets from experiments at the University of Guelph in Ontario were accidentally sent to a meat rendering plant and turned into animal feed instead of being destroyed as biological waste.
- In 2004, three experimental GM pigs from the now-defunct Quebec company TGN Biotech were accidentally turned into chicken feed instead of being incinerated.

These incidents illustrate the relevant role of human error in containment failure. In the case of this GM fly, they also raise the question about how realistic it is to expect containment with such a small organism when containment could not be achieved with these larger organisms. The risks of containment failure may be amplified with the production of these smaller, more mobile genetically modified animals, though the short lifespan of the GM fly may reduce the risks of a contamination outcome.

The two containment failures with GM pigs, along with others like it, illustrate the basic truth that **the containment of GMOs may fail even when containment seems feasible.**

In response to the incident at the University of Guelph, the Vice President of Research provided the insight that, **“Things you don’t expect to happen can happen.”** (S. Strauss, “Accident raises GMO-research flag,” *The Globe and Mail*. February 19, 2022.)

The key lesson that needs to be heeded is our inability to contain living modified organisms. This lesson has been learned over and over, by companies, universities, farmers, and governments. Our 2019 report concluded that the diverse incidents of GM escape and contamination in Canada show that the risks cannot be managed by current government regulation nor through industry-developed best practices.

We therefore argue that this GM fruit fly cannot be produced without expecting containment failure, and that ECCC therefore needs to assess the potential ecological and health impacts of escape.

Ecological and Human Health Effects

Once released into our environment, genetically modified organisms can be difficult or impossible to control or recall. This would be the case with a GM fruit fly.

We therefore ask ECCC to assess the ecological and health effects of any potential escape, rather than just constrain assessment to containment plans.

If ECCC proceeds with this GMO evaluation, we ask ECCC to release details of the proposed production of this organism as well as the full ECCC risk assessment for public comment before any decision is made.

CBAN brings together 15 groups to research, monitor and raise awareness about issues relating to genetic engineering in food and farming in Canada. CBAN members include farmer associations, environmental and social justice organizations, and regional coalitions of grassroots groups. CBAN has over a decade of experience in researching and monitoring the impacts of genetically modified organism (GMOs), including examining the issues raised by the possible release of genetically engineered trees. CBAN is a project of MakeWay's shared platform. www.cban.ca

Annex 1

Company genetically engineers fruit flies to be "biofactories" for fake meat production

GMWatch

11 January 2023

<https://www.gmwatch.org/en/106-news/latest-news/20155-company-genetically-engineers-fruit-flies-to-be-biofactories-for-fake-meat-production>

Future Fields' EntoEngine insects have serious environmental and ethical downsides. Report by Claire Robinson; technical advice by Dr Michael Antoniou

The biotech company Future Fields has [notified](#) the Canadian authorities of its intention to commercialise EntoEngine, a genetically modified fly. The flies are engineered to produce foreign proteins – in this case, growth factors, which are cell signalling molecules that play important roles in cell proliferation and development, for use in what Future Fields calls "cellular agriculture" – what we call lab-grown or fake meat.

The public can [comment](#) on the application until 28 January 2023 and we encourage them to do so. In our view, EntoEngine flies poses serious environmental risks in the likely event that they will escape contained conditions.

The details

The company [says](#), "The EntoEngine fly line has been genetically engineered to express a growth factor isolated from cows.... The gene sequence poses no known risks to either humans or animals. Expression of the gene encoding the growth factor is under the control of a gene expression regulator isolated from yeast."

Future Fields argues that the GM fly is needed to replace the usual way of producing growth factors – in bioreactors. The company [confirms](#) what GMWatch has long [said](#) – that bioreactor technology is expensive, resource and energy hungry and produces vast quantities of problematic waste. The company concludes, reasonably, that growth factors [cannot](#) be produced cost-effectively using bioreactor technology – so they aim to produce them in GM drosophila, or fruit flies.

The company makes grand claims for the fly's [sustainability](#) and environmental [friendliness](#), compared with bioreactor protein production, based on lower input use and less greenhouse emissions. Drosophila, Future Fields says, "do not have these large operation costs and require only modest environmental controls to ensure optimal rearing... Drosophila can feed on organic side streams and byproducts from other processes (i.e. organic waste). In fact, insects are some of the most efficient organisms at converting nutrients into biomass."

However, the problem with this "solution" is that even with a cheaper source of cell growth factors in the shape of the flies, lab grown meat will still need to be produced in huge bioreactors, with the consequent [vast running costs and environmental impacts](#).

Patent

Future Fields describes the status of the patent on EntoEngine as "pending". Our patent search on the Espacenet and USPTO databases only found one [patent](#) on a GM insect with

Future Fields as an applicant. The patent, titled "Method for producing recombinant proteins in insects", describes the general concept patent but lacks the experimental data to prove that the system actually works. It's unclear whether other patents exist, but the details of this patent illustrate the types of process that would be used for EntoEngine protein production.

The patent focuses on heat stress (taking the temperature up to 35-40 degrees C) as the trigger that will activate expression of the transgenes in the flies to produce the desired growth factors.

The expression of the transgenes encoding for the desired protein (in this case, mammalian cell growth factors) is under the control of a "gene expression regulator" derived from yeast. So these flies would appear to contain two foreign transgenes: One encoding the desired protein to be expressed and isolated from the flies; and the other encoding the yeast gene expression regulator.

In all likelihood, the yeast-derived gene expression regulator is a member of the heat shock factor family of proteins. The function of these proteins is elevated upon heat stress and their role is to increase expression of genes that will help the organism protect itself from external stresses (e.g. heat, cold, UV light).

Torturing fruit flies

Regarding the heat stress trigger, the patent describes a gruesome and torturous process of gradually getting the flies used to the higher temperature of the heat stressor so that they don't die from the shock of a sudden rise, by applying the stressor interspersed with "rest" periods.

When the insects have exhausted their ability to produce growth factor, they are killed and "harvested", in the words of the Future Fields patent, then ground up into a mass, and the desired protein is extracted and purified out. It is unclear how well the purification process will work and GMWatch warns that native fly proteins could end up contaminating the final product.

Doubtful ethics

The company's patent and publicity make a big deal out of the supposedly superior ethics of using fruit flies to manufacture growth factors for "cellular agriculture", as opposed to extracting them from fetal bovine serum (FBS) taken "from fetuses of pregnant cows prior to slaughter". The patent says that cattle-derived FBS gives rise to "ethical concerns regarding the production of cultured meat products".

But the point on ethics is disingenuous and contradictory, as Future Fields itself [justifies](#) its GM flies approach as replacing growth factors produced in bioreactors and not as replacing FBS, because FBS is not used by the lab grown meat industry.

Along the same lines, Future Fields' use of language in its patent seems manipulative. While the cattle from which FBS is derived are subject to "slaughter", the GM fruit flies are merely "harvested", just like the crop plants that even vegans would be happy to eat.

But anyone concerned with the ethics around animal use in agriculture is unlikely to be impressed by Future Fields' description of its GM fly as "[a standalone biofactory](#)" – the

ultimate reduction of a living creature to a machine.

At a time when prominent environmentalists, from Sussex University's Prof Dave Goulson to TV's David Attenborough, are trying to persuade the public to give insects the respect they deserve as key regulators of ecosystems, genetically engineering fruit flies and then characterising them as "biofactories" or as non-sentient beings on a par with a wheat or maize crop seems distasteful in the extreme.

By timely coincidence, recently published EU-funded [research](#) shows that fruit flies, though "tiny", are "amazingly smart". They are capable of attention, working memory and conscious awareness – abilities we usually only associate with mammals.

Environmental risks

The main risk posed by the GM flies is environmental. Containment facilities for GM animals are notoriously insecure – [GM glofish](#) have escaped from tanks and are breeding in the wild in Brazil and a whistleblower [report](#) paints a damning picture of lax attitudes and neglect of protocols at AquaBounty's GM salmon-producing facilities. The risk with GM flies is that they could escape and breed in the environment or cross-breed with natural flies, leading to the escape of growth factor-producing genes into wild populations.

This wouldn't pose a human health risk, as most of us don't eat living fruit flies and the proteins in dead flies would quickly degrade. But plenty of animals, including mammals, fish, amphibians, and birds, do eat living flies. Because the growth factors in the GM flies are mammalian, they will to some degree be active in any animal that ingests them. This could cause uncontrolled cell division in the animal consumer – potentially leading to cancer.

In evaluating environmental risk in the case of an escape, much depends on what triggers are used to make the growth factor-producing genes express. The heat stress triggers discussed in the patent are worrying because they are designed to spring into action at 35-40 degrees C – temperatures regularly reached in the climate conditions of many parts of the world. And this raises the question: What happens at 31 or 32 degrees? Nothing, or something? And if something, then what?

Conclusion

Future Fields' GM fly appears to be an invention of dubious utility that will do little to improve the sustainability of the environmental catastrophe-in-the-making that is lab grown meat. It poses unacceptable environmental risks in the event of an escape and the ethics around the GM fly's grim life and grimmer death are dubious, to say the least.