Inside JEB highlights the key developments in *The Journal of Experimental Biology*. Written by science journalists, the short reports give the inside view of the science in JEB.

Inside JEB

OMEGA-3 DIET MAKES COUCH POTATO QUAILS FIT

When tiny semipalmated sandpipers embark on their annual odyssey from the Canadian Arctic to their winter residences in South America, they set out on one of the world's longest migrations. On the way, the tiny birds stop off at the Bay of Fundy on the Canadian east coast, where they spend two weeks gorging on a superfood, *Corophium volutator* (mud shrimps), which have some of the highest levels of n-3 fatty acids (better known as omega-3 fatty acids) of any marine animal.

According to Jean-Michel Weber from the University of Ottawa, omega-3 fatty acids have some rather astonishing effects. In humans they reduce the risk of coronary heart disease and alleviate depression. But it was not their potential medicinal properties that intrigued Weber; it was their ability to increase aerobic capacity, much like endurance training. Could the sandpipers be building up for their endurance challenge by simply eating? All the evidence seemed to suggest so, but Weber needed to test the miraculous fatty acids' effects on less athletic birds, bobwhite quails. Could he boost the couch potato quails' endurance by simply feeding them omega-3 fatty acids and so convince himself that the sandpipers' mud shrimp feeding frenzy made the voyagers fit (p. 1106)?

Teaming up with student Simba Nagahuedi, Weber fed three groups of the sedentary quails a tightly regulated omega-3 diet of n-3 eicosapentaenoic acid, or n-3 docosahexaenoic acid, or a 50/50 mixture of the two oils for 6 weeks. Then Nagahuedi checked the quails' pectoral muscles to see if their capacity to consume oxygen to produce energy had improved. Measuring the activity levels of four oxidative enzymes the duo found that the enzymes' activity levels had increased by between 58 and 90% to levels normally only seen in the migrating sandpipers. Weber admits that he was astonished by the increase. Even top human endurance athletes only improve their oxidative enzyme activities by 38 to 76% after 7 weeks of hard endurance training. But the quails had done even better without getting off their bottoms; they had got fit by simply eating omega-3 fatty acids.

However when Weber tried to find out how the enigmatic fatty acids manifested their remarkable influence, the results were less clear. Teaming up with Vance Trudeau and Jason Popesku to measure the levels of a key molecule that regulates oxidative enzyme levels, known as PPAR, Weber could not find any evidence for a change in PPAR gene expression in response to the 6 week diets. However, he adds that it does not mean that PPAR levels do not change earlier to influence the bird's performance during the oil diet.

Nagahuedi and Weber also measured the omega-3 fatty acid levels in the muscle cell membranes, and found that the fatty acid was evenly distributed between all of the different membranes in muscle cells. So the birds were not improving their endurance by selectively allocating the fatty acids to the energy generating mitochondria.

Having convinced himself that the sandpiper's mud shrimp diet is responsible for the migrant's outstanding stamina, Weber is keen to find out exactly how the birds increase their oxidative enzyme activity levels to power their long flight south.

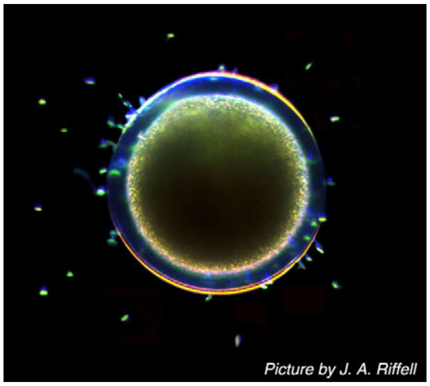
10.1242/jeb.031468

Nagahuedi, S., Popesku, J. T., Trudeau, V. L. and Weber, J.-M. (2009). Mimicking the natural doping of migrant sandpipers in sedentary quails: effects of dietary n-3 fatty acids on muscle membranes and PPAR expression. *J. Exp. Biol.* **212**, 1106-1114.

ABALONE SPERM FOLLOW Trp TRAIL TO FIND EGGS

It's an everyday story: boy meets girl, they fall in love and the rest is history: but not if you're a red abalone. They cast their gametes into the sea and leave it up to the sperm to do the chasing. Or do they? Richard Zimmer from the University of California, Los Angeles, explains that eggs don't leave this encounter to chance. They release an amino acid, tryptophan (Trp), to attract and guide keen sperm their way. Having previously identified tryptophan as the guidance molecule, Zimmer, Patrick Krug and Jeff Riffell focused their attention on the molecule's source, the egg, to find out more about how abalone eggs communicate with their suitors (p. 1092).

First the team decided to investigate the levels of 19 amino acids found dissolved in



Picture by J. A. Riffell

abalone tissue, to see if the molluscs' tryptophan levels were particularly high. But they weren't. Tryptophan levels were low in all of the abalone's tissues, except for the eggs, which had levels higher than all of the mollusc's other tissues and 3 times higher than the mollusc's ovaries. And when the team tested the eggs, they found that the amino acid was being released from the egg's cytoplasm, and not the protective surrounding gel.

Having found that the eggs are enriched with tryptophan, Zimmer was curious to find how quickly newly spawned eggs release tryptophan to attract the free-swimming sperm. Collecting freshly spawned eggs, Zimmer and Riffell placed 100 eggs into each of 13 separate Petri dishes containing fresh seawater. Collecting one seawater sample from each Petri dish at times ranging from 1 min up to 2 h, the duo handed the precious seawater samples to Patrick Krug to measure the tryptophan levels by HPLC analysis. At the same time as they took the seawater sample, Zimmer and Riffell tested the fertility of the eggs to see how it had changed as the eggs grew older. They added sperm to the eggs and incubated them for 3 h before counting how many of the eggs were fertilised successfully.

After weeks of meticulous HPLC analysis on the dilute seawater samples, Zimmer was delighted to see that the seawater's attractive tryptophan levels increased linearly up to 45 min after spawning. But then something changed. The tryptophan levels in the Petri dishes suddenly dropped. And when the team checked the eggs' fertility, they could see that it also fell dramatically at the same time. The eggs simultaneously stopped releasing tryptophan as their fertility began to decline. What was more, the tryptophan that had been released by the eggs began to vanish.

Zimmer admits that he hadn't expected this unusual tryptophan release profile and suspects that the older infertile eggs cut the tryptophan communication line to improve the chances of other fertile eggs attracting promising sperm. However, how the eggs eliminate the accumulated signal is less clear.

And having thought long and hard about why the mollusc has opted for tryptophan to attract suitors, Zimmer suggests that tryptophan could be an honest advert for the egg's fitness. Zimmer explains that tryptophan is a precursor for a key molecule involved in neural development, and suspects that releasing a strong plume of tryptophan could be the best way of advertising that the egg has a good chance of going on to produce a fine new abalone, so long as it attracts the right sperm mate.

10.1242/jeb.031443

Krug, P. J., Riffell, J. A. and Zimmer, R. K. (2009). Endogenous signaling pathways and chemical communication between sperm and egg. *J. Exp. Biol.* **212**, 1092-1100.

INUIT SLED DOGS' AMAZINGLY PLASTIC MUSCLES

Picture by Nadine Gerth

For many animals summer is a time of activity, but not for Inuit sled dogs. According to Nadine Gerth from the University of Munich LMU, it is when they are most sedentary. Chained to rocks by law, the dogs spend their summers inactive and are fed once every few days as they wait for the sea ice, and hunting season, to return. During their lazy summers, the dogs lose muscle as they lie around and fast, but as soon as they can return to the ice, the dogs build up muscle ready for months dragging sleds on the ice for their Inuit masters. Gerth explains that this is a classic example of muscle phenotypic plasticity, as the animals' muscles waste during the summer and rebuild for the winter. Curious to find out how the dogs' muscles fair during the active winter and idle summer, Gerth and her colleagues, Steffen Sum, Sue Jackson and Matthias Starck, headed north to the animals' Greenland homes to measure their muscles (p. 1131).

But it soon became clear that the team could not test the animals in the way they had hoped. Gerth explains that the team had wanted to compare the inactive animals with working animals during the same season, but 'it was completely impossible to get them to work in the summer,' she says; 'there was no sea ice for them to work on and they overheat'. It was also impossible to compare inactive and active animals during the winter because the dogs must drag sleds for the hunters. Fortunately the team realised that the dogs' lifestyles varied sufficiently in different parts of the country for them to test environmental effects on the dogs' muscles; the Western Greenland dogs are no longer involved in winter hunting.

Heading to Qaanaaq in Northern Greenland and Qeqertarsuaq in Western Greenland, the team took muscle biopsies, for analysis back in the lab, and measured the thickness of the dogs' leg and shoulder muscles by ultrasound in the summer. They returned to repeat the biopsies and ultrasound on the same dogs in the winter.

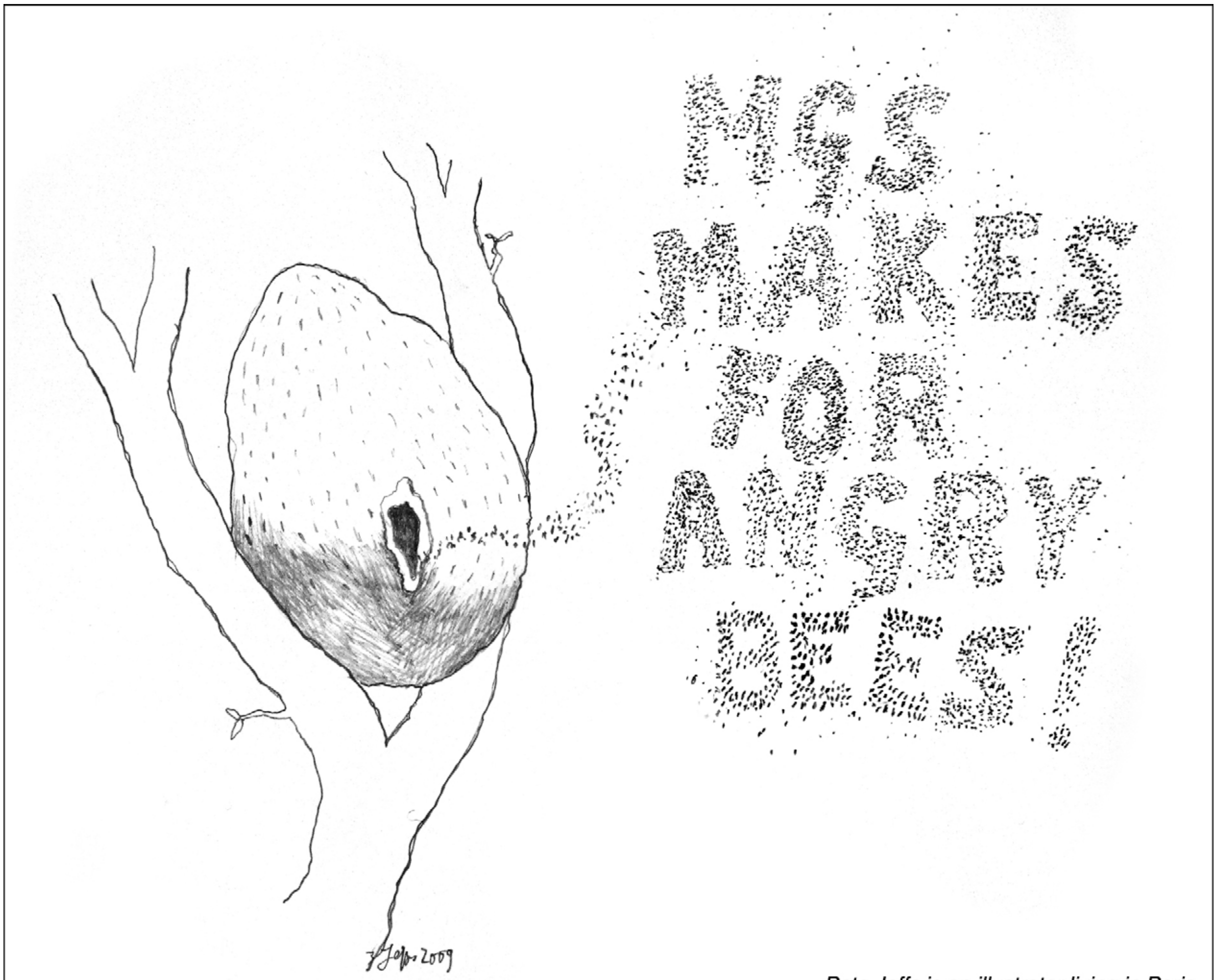
Analysing the data back in Munich, Gerth could see that the muscles of dogs from both regions were relatively withered in the summer, but the dogs from Western Greenland suffered most muscle wastage as they were on a poorer diet. Looking at the microscopic muscle samples, the team could also see that the muscle fibres were much thinner in the summer, when the dogs were inactive and fasting, than in the winter, when the animals were well fed and working. The summer dogs also had lower levels of fat in their muscle tissue and fewer energy generating mitochondria than they had during the winter. The animals' muscle fibres are extremely flexible and are able to respond to the different physical demands and diets.

Most surprisingly, the network of blood capillaries in the muscles didn't alter from season to season, so the dogs had a higher density of capillaries in the summer than they did in the winter. Gerth explains that this was unexpected, but suspects that instead of scaling back their capillary system during their inactive summer, they maintain it in preparation for winter, which is only round the corner.

10.1242/jeb.031450

Gerth, N., Sum, S., Jackson, S. and Starck, J. M. (2009). Muscle plasticity of Inuit sled dogs in Greenland. *J. Exp. Biol.* **212**, 1131-1139.

MANDIBULAR GLAND SECRETIONS MAKE BEES DEFENSIVE



Pete Jeffs is an illustrator living in Paris

Most bees are famed for their stings, but not Meliponini. They have almost done away with their sting and resort to other alternatives for defence, such as nipping with their powerful mandibles. The stingless bees also produce pheromones from glands situated close to their mandibles. The secretions certainly seem to encourage stingless bees to defend themselves, but whether the mandibular gland secretions also attract the bees to rich nectar supplies has been hotly debated. Curious to find how the secretions function, Dirk Louis Schorkopf, working with colleagues from the University of Vienna and the University of São Paulo, investigated the mandibular secretions from two stingless bee species (*Trigona spinipes* and *Scaptotrigona* aff. *depilis*) (p. 1153).

Analysing the composition of the secretions, the team found that they are complex. *T. spinipes*' mandibular gland secretions comprise at least 31 components, while *S.* aff. *depilis*' secretions comprise at least 27 components. The secretions of the two species also share 10 compounds, including the major component 2-heptanol, possibly allowing bees from the two species to communicate. Schorkopf explains that this makes sense because both species share the same habitat and probably compete for food.

Testing the pheromones' effects on the bees, Schorkopf and his colleagues found that the pure mandibular gland secretions, and their individual components, caused the bees to behave defensively when the insects chose to respond. However, the team could not find any evidence that the bees used the pheromones to lay scent trails to rich nectar supplies. 'While confirming the role of the mandibular glands in nest defence, our experiments provide strong evidence against their role in food source signalling,' says Schorkopf.

10.1242/jeb.031476

Schorkopf, D. L. P., Hrncir, M., Mateus, S., Zucchi, R., Schmidt, V. M. and Barth, F. G. (2009). Mandibular gland secretions of meliponine worker bees: further evidence for their role in interspecific and intraspecific defence and aggression and against their role in food source signalling. *J. Exp. Biol.* **212**, 1153-1162.

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