Bees and the mathematical truth

1 **Read the article and complete it with the sentences given below. Choose from sentences A – O to fit gaps 1-11. There are two extra sentences. The first one (0) is an example.**

Bees could build honeycombs **0.** .....*P*..... or triangles. But for some reason, they always choose "perfect" hexagons for the cells of their honeycomb. Why? This is **1.** ..... was proposed by a Roman soldier-scholar-writer, Marcus Terentius Varro, in 36 BC. Varro thought there might be a deep reason for this bee behaviour: maybe a honeycomb built of hexagons can hold more honey; maybe hexagons require less building wax; **2.** ..... .

As honey is so valuable to bees and entails thousands and thousands of working hours to gather it, it's reasonable to suppose that bees need a secure storage structure, without gaps between cells, **3.** ..... possible. How do they build it? Do the worker bees work sequentially, one at a time, first making once cell, then fitting the next cell to that, and so on? Absolutely not! Instead, everybody's working. They do this collectively, simultaneously and constantly, *so* it's simpler for each cell to be exactly the same. If the sides are all equal – "perfectly" hexagonal – every cell fits tight with every other cell, **4.** ..... .

But why the preference for a six-sided shape? A honeycomb built from other shapes **5.** ....., thus creating gaps that would need extra wax for patching. It is a mathematical truth that there are only three geometrical figures **6.** ..... on a flat surface without leaving gaps: equilateral triangles, squares and hexagons.
Varro proposed that a structure built from hexagons **7.** ..... a structure built from squares or triangles. A hexagonal honeycomb, he thought, would have "the smallest total perimeter". He couldn't prove it mathematically, **8.** ..... Compactness matters. The more compact your structure, the less wax you need to construct the honeycomb. Wax **9.** .....
A bee must consume about eight ounces of honey to produce a single ounce of wax.
Two thousand thirty-five years after Varro proposed "The Honeybee Conjecture", a mathematician at the University of Michigan, Thomas Hales, solved the riddle. Varro was right: **10.** ..... of engineering. A hexagon is such a compact structure **11.** ..... economizing labour and wax.



Bees knew it was true all along.

The Green Planet - Copyright © EDISCO Editrice - Vietata la vendita e la diffusione

A	is expensive	
B	the honeycomb is a masterpiece	
C	like a jigsaw puzzle	
D	a queen has got two parents, a queen and a drone	
E	but that's what he thought	
F	maybe there's a hidden logic here	
G	bees have got interesting family trees	
H	would have little spaces between each unit	
I	that it is absolutely perfect in	
L	with equal sides that can fit together	
M	a very old question, whose answer	
N	that could be as simple to build as	
O	is probably a bit more compact than	
P	rectangles or squares or	0



The Green Planet - Copyright © EDISCO Editrice - Vietata la vendita e la diffusione