

Pilobolus

Pilobolus or “Dung Cannon” are one of the interesting *Zygomycete* genera found on the dung of herbivores. While many field mycologists are aware of them they are rarely studied by non-specialists and have very few entries in the popular books. They develop their spores in a black cap (sporangium) at the top of a transparent stalk and have developed an innovative way of spore distribution. As the spores need to travel through an animal gut to maintain their life cycle various things need to occur. First it is necessary to ensure the spores are ejected outside the “zone of repugnance” i.e. where animals would not eat the grass as it is too close to the dung. To achieve this feat the stem swells with mucus to create a vesicle just under the sporangium which can reach a pressure of 100lbs psi and this is the power behind the unusually explosive distribution of the spores. It has often been quoted that this species is the “fastest thing in nature” but as the maximum speed the ejected sporangium achieves is a modest 12mph this is hardly the case. What is remarkable is that this maximum speed is reached after 0.2 μ s thus generating an acceleration of 20,000g. To stand the best chance of being consumed the sporangium is fired towards the sun which is where an open area is most likely to be found. As the sporangium is so small it travels furthest when it is fired not at the expected angle of 45° but one of about 15°. These criteria are achieved by the fruit-body having a light-sensitive “retina” and a circadian clock which together adjust its growth so when mature it points towards the sun as it reaches the appropriate height in the sky. The final requirement is that the sporangia stay on the grass and do not drop too low to be eaten. This is accomplished by a small amount of the mucus from the vesicle being fired with the sporangium thus creating a sticky pad. To back this up the top surface of the sporangium is hydrophobic ensuring that if it happens to land in a drop of dew on the grass it will rotate to allow the sticky pad to take hold.



Figure 1 Clockwise from top left *Pilobolus crystalinus*, *P kleinii*, *P lentiger*, *P umbonatus*, *P rorida* and *P oedipus*

As can be seen from the photos the sporangia are subtly different shapes but the only one that is distinctive enough to be used as a defining character is *Pilobolus umbonatus*.

Obtaining literature to help with the identification is not easy but there are papers from Brazil, India, China and the USA. The criteria used for identifying the species have included the size and shape of the trophocyst (a characteristic swelling of the root system), sub sporangial swelling, sporangia and the size, shape and colour of the spores. This has led to over 50 species being described over the years but it is now generally accepted that there are between 5-10 species.

The Fungal Records Database of Britain and Ireland has five species and two varieties, the Chinese paper (Hu, Zheng & Chen 1989) describes five species and four varieties and both the Brazilian (Airton Viriato 2008) and Indian (Nand & Mehrotra) studies ten species.

Papers from the USA (Foos 1988, 2011, 2011) using DNA sampling suggested that two of the varieties should be elevated to full species (*P. kleinii* and *P. umbonatus*) and found that the most important feature in identifying *Pilobolus* was the spore details. If we accept this premise then identifying the different species is relatively straightforward with the aid of a microscope. More consistent results are achieved from released sporangia

but this does lead to problems storing specimens for a herbarium as there can be two or more species in the same dung sample.

Although at the moment in the UK we have *P. heterosporus* synonymised with *P. kleinii* there appear to be at least two species hiding under this name. The spores are described in various papers as everything from globose, sub-globose, cylindrical through to irregular. Of the species that appear to fall into this group I have keyed out the irregular spored species into *P. heterosporus* and all others into *P. kleinii* (*P. heterosporus* sp).

The following Key is for the currently accepted British species plus my understanding of *P. heterosporus*

- 1 Sporangia umbonate.....*P. umbonatus*
- 1 Sporangia not umbonate.....2
- 2 Sporangiphore 10 – 50mm trophocyst formed outside the substratum.....*P. longipes*
- 2 Sporangiphore under 5mm and trophocyst within the substratum.....3
- 3 Spores cylindrical to ellipsoid.....6
- 3 Spores globose or subglobose.....4
- 3 Spores irregularly shaped.....*P. heterosporus*
- 4 Spores thick walled.....*P. oedipus*
- 4 Spores thin walled.....5
- 5 Spores globose 8-18.5µm.....*P. lentiger*(*sphaerosporus*)
- 5 Spores subglobose 8-15 x 6-12 µm.....*P.kleinii* (*heterosporus* sp)
- 6 Spores 4-7 x 3-4.5 µm.....*P. roridus*
- 6 Spores 7.5-11 x 5-7.5 µm pale yellow.....*P. crystalinus*
- 6 Spores 10-19.5 x 5.5-10.5 µm usually deeper yellow/orange.....*P. kleinii*

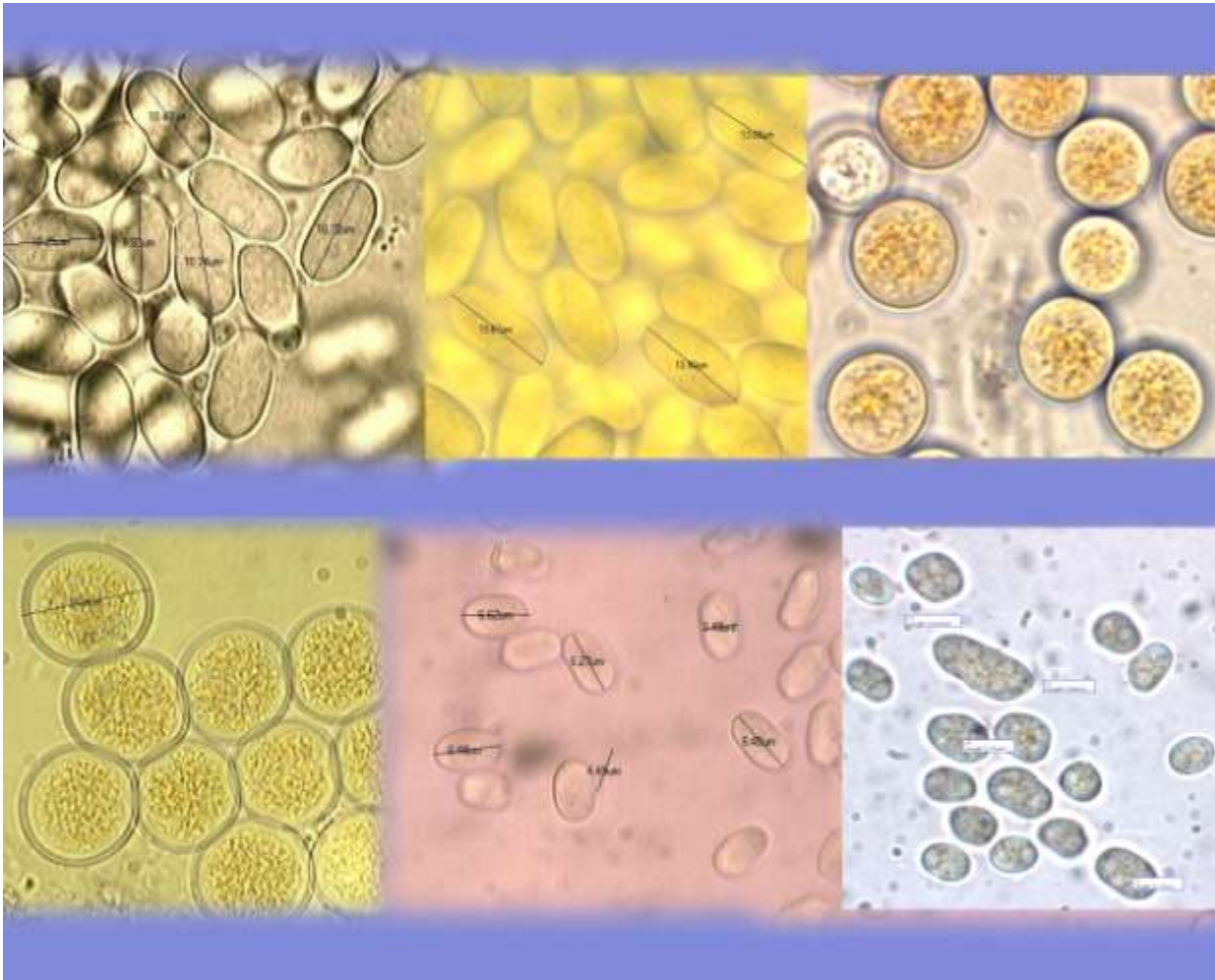


Figure 2 Clockwise from top left *Pilobolus crystalinus*, *P. kleinii*, *P. lentiger*, *P. heterosporus*, *P. roridus* and *P. oedipus*

The next time you spot a pile of horse dung which looks “hairy” it could well be worth a closer look.

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References

FOOS M.K., MAY N.L., BEACH D.L., POMPER M., SHEENAN K.B., RUCH D.G. Phylogeny of *Pilobolaceae* *Mycologia*, 103(1), 2011, pp. 36–44. DOI: 10.3852/09-314

FOOS M.K., JEFFRIES B.S. 1988. Sporangiospore Variability in *Pilobolus*, *Proceedings of the Indiana Academy of Science* (1988) Volume 98 p. 105-108.

FOOS M.K., SHEEHAN K.B. Molecular identification of *Pilobolus* species from Yellowstone National Park. *Mycologia*, 103(6), 2011, pp. 1208–1215. DOI: 10.3852/11-107

HU, F.-M., R.-Y. ZHENG, AND G.-G.CHEN. 1989. A redelimitation of the species of *Pilobolus*. *Mycosystema* **2**: 111-133.

VIRIATO, A. 2008. *Pilobolus* species found on herbivore dung from the São Paulo Zoological Park, Brazil. *Acta bot. bras.* **22(3)**: 614-620.