Ophidiomyces ophidiicola in Britain, the cause of ophidiomycosis (snake fungal disease)

Steven J.R. Allain* & Tony Leech**

If it is the case that plant pathogenic fungi are under-recorded on FRDBI (Henrici, 2021), animal pathogenic fungi are likely to be even less well recorded. This is because unambiguous identifications can rarely be made from observing the lesions present, and the techniques available for identification are not generally available to the field mycologist. However, skin infections caused by the keratinophilic fungus *Ophidiomyces ophidiicola*, which has been recently shown to occur in Britain, are visible on the sloughed skins of Barred Grass Snakes (*Natrix helvetica**) and so could come to the attention of field mycologists.

Ophidiomyces ophidiicola was first described (as *Chrysosporium ophiodiicola*) by Rajeev *et al.* (2009) from a captive Black Rat Snake (*Elaphe obsoleta obsoleta*) that had been taken from the wild in Georgia, USA. It was shown to be distinct from other *Chrysosporium* anamorphs that cause scale infections in a wide variety of reptiles by its sequence in the ITS region and the morphology of its conidia. *Chrysosporium ophiodiicola* was reported to produce conidia measuring 4–6.5 (9) x 2–3 µm at the termini of hyphae and on lateral branches, and arthroconidia measuring 7.5–10 x 2–2.5 µm from fragmenting hyphae.

The genus *Ophidiomyces* was erected to accommodate this fungus in 2013 when DNA sequencing showed it to be genetically distinct from members of the genus *Chrysosporium*. The teleomorph is not known. The fungus belongs to the order *Onygenales*, members of which are able to decompose keratin, the major protein component of skin, hair and feathers.

Ophidiomycosis, or snake fungal disease (SFD), for which *O. ophidiicola* is the primary causative agent, was first recognised in 2006 in Timber Rattlesnakes (*Crotalus horridus)* in New Hampshire, USA. The disease has now been recorded in dozens of snake species in both North America and Europe (Burbrink *et al.*, 2017; Blanvillain *et al.*, 2024). In a retrospective examination of pathology material collected from captive snakes at the Smithsonian National Zoological Park, Washington DC, USA, the fungus was found in seven species of snake with the earliest record from 1983 (Anderson *et al.*, 2021). The first British record of the disease in which association with *O. ophidiicola* was confirmed was in 2015 from a Grass Snake found in eastern England (ARC Factsheet), although the earliest case of the disease known so far dates back to 2010 thanks to the use of a slough archive (Franklinos *et al.*, 2017). The locations of these occurrences have not been published. So far there have been a limited number of cases from both wild and captive snakes recorded in Asia (Sun *et al.*, 2022; Takami *et al.*, 2021), as well as in Africa and South America. This means that we currently lack the data to determine whether *O. ophidiicola* is native to Great Britain or whether it has been introduced. So far, no species of lizards have been found to be infected with *O. ophidiicola*.

Clinical signs of ophidiomycosis and the severity of disease vary from species to species. The most common signs, seen on the ventral surface of the snake, include: flaking and crusting of the scales, displaced or discoloured scales, more frequent moulting and the swelling of infected tissues (Figs. 1 & 2). The appearance of clinical signs may be affected by co-infections with other fungi or bacteria. Lesions can be seen on sloughed skins. In some snakes, the effect of the fungus appears superficial and seems to cause no serious issues. Indeed, it is possible for *O. ophidiicola* to be detected by PCR on a snake without

[*Footnote: Recent taxonomic revision has resulted in the native British grass snake formerly known as the Common Grass Snake (*Natrix natrix helvetica*) becoming the Barred Grass Snake (*N. helvetica*). For more information, see Kindler *et al.* (2017)]

Fig. 1. Ventral scales of a Barred Grass Snake showing clinical signs of ophidiomycosis including changes in colour, crusting and scale margin erosion. For more details see Allain *et al*. (2024). Photo: Steven Allain.

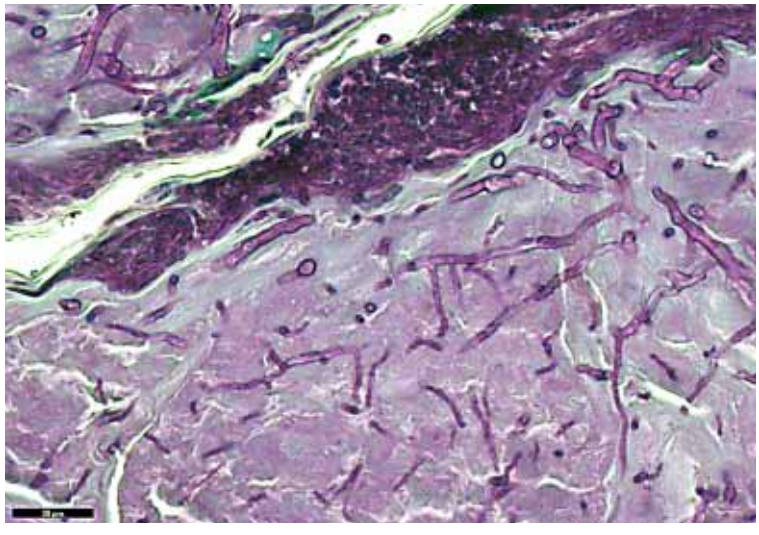

Fig. 2. Photomicrograph showing numerous branching fungal hyphae of *Ophidiomyces ophidiicola* associated with an area of epidermal thickening and necrosis. Periodic acid-Schiff stain; magnification 600x. Reproduced with permission from the Zoological Society of London.

observable symptoms – perhaps as a consequence of subclinical infection. Conversely, the disease may progress to infect internal organs, and in some snake populations in North America mortality is significant (Lind *et al*., 2018). Effects on behaviour, particularly a tendency for snakes to spend more time in the open thus increasing the incidence of hypothermia and predation, may contribute to mortality.

Between 2010 and 2016, 33 carcasses and 302 moulted skins of three species of snake were collected in Britain and examined for skin lesions and the presence of *O. ophidiicola* DNA (Franklinos *et al*., 2017). Skin lesions were observed in nearly one quarter of the samples, and, of these, about half of the Grass Snake samples showed the presence of *O. ophidiicola* DNA. No such DNA was detected on any of the seven Smooth Snake (*Coronella austriaca*) samples with lesions. One Adder (*Vipera berus*), without skin lesions, was PCR positive. This study was the first demonstration of *O. ophidiicola* in wild European snakes and also showed that the presence of this fungus could not be assumed from the appearance of the lesions alone.

From 2019 to 2021, one of us (SJRA) studied the large population of *N. helvetica* at Watermill Broad, Cranwich, in south-west Norfolk (TL7795), where almost 30% of individual snakes identified had skin lesions consistent with ophidiomycosis (Allain *et al*., 2024). The majority of

these were positive for *O. ophidiicola* DNA. As well as using PCR to determine the presence of *O. ophidiicola*, histology was carried out to detect the fungal hyphae and arthroconidia associated with the fungus in some *N. helvetica* carcasses and skin sloughs.

It is assumed that transmission of ophidiomycosis is by spores acquired from the environment or by direct contact between snakes. This clearly has implications for workers handling snakes from different sites, and strict biosecurity protocols should be used when moving between sites where populations of snakes are known. This does not just affect those of us working with wild reptiles, but everyone who utilises the countryside to observe the natural world, as we could be inadvertently spreading the spores around to unsuspecting populations of our vulnerable reptiles.

Acknowledgements

We would like to thank past and present Trustees of Watermill Broad Nature Reserve, Cranwich, Norfolk, for granting us access to study the population of *N. helvetica* present at the site. Additionally, SJRA would like to thank his supervisory team and collaborators for the support throughout his doctoral studies as described above.

* steveallain@live.co.uk
** tonyleech3@gmail.com

References

Allain, S.J.R., *et al*. (2024) Characterisation, prevalence and severity of skin lesions caused by ophidiomycosis in a population of wild snakes. *Scientific Reports* 14, 5162. https://doi.org/10.1038/s41598-024-55354-5

Amphibian and Reptile Conservation. *Snake Fungal Disease* (SFD). arc-trust.org/snake-fungal-disease.

Anderson, K.B., *et al*. (2021). Retrospective review of ophidiomycosis (*Ophidiomyces ophiodiicola*) at the Smithsonian's National Zoological Park (1983-2017). *Journal of Zoo and Wildlife Medicine* 52(3): 997–1002.

Blanvillain, G., *et al*. (2024). Contribution of host species and pathogen clade to snake fungal disease hotspots in Europe. *Communications Biology* 7(1): 440.

Burbrink, F.T., Lorch, J.M. & Lips, K.R. (2017). Host susceptibility to snake fungal disease is highly dispersed across phylogenetic and functional trait space. *Science Advances* 3(12): e1701387.

Franklinos, L.H.V., *et al*. (2017). Emerging fungal pathogen *Ophidiomyces ophiodiicola* in wild European snakes. *Scientific Reports* 7: 3844. https://doi.org/10.1038/s41598-017-03352-1

Henrici. A. (2021). Notes and records. *Field Mycology* 22(4): 141–142.

Kindler, C., *et al*. (2017). Hybridization patterns in two contact zones of grass snakes reveal a new Central European snake species. *Scientific Reports* 7: 7378.

Lind, C.M., McCoy, C.M. & Farrell, T.M. (2018). Tracking outcomes of snake fungal disease in free-ranging pygmy rattlesnakes (*Sistrurus miliarius*). *Journal of Wildlife Diseases* 54(2): 352–356.

Rajeev, S., *et al*. (2009). Isolation and characterization of a new fungal species, *Chrysosporium ophiodiicola*, from a mycotic granuloma of a Black Rat Snake (*Elaphe obsoleta obsoleta*). *Journal of Clinical Microbiology* 47(4): 1264–1268.

Sun, P.L., *et al*. (2022). Infection with *Nannizziopsis guarroi* and *Ophidiomyces ophiodiicola* in reptiles in Taiwan. *Transboundary and Emerging Diseases* 69(2): 764–775.

Takami, Y., *et al*. (2021). First report of ophidiomycosis in Asia caused by *Ophidiomyces ophiodiicola* in captive snakes in Japan. *Journal of Veterinary Medical Science* 83(8): 1234–1239.