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The pyrophysiology and sexuality of dragons

S.T. Georgy [1], J.G. Widdicombe *, (with the assistance of V. Young) [2]

Department of Physiology, St. George's Hospital Medical School, London SW17 0RE, UK

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Abstract

To examine the means whereby dragons produce fire and steam, we have studied a related species, the desert-lizard *Lacerta pyrophorus.* Morphological studies showed that there were in the snout three distinctive features: (1) a dorsal swelling in the pharynx, the Organ of Feuerwerk, consisting of brown adipose tissue with an extensive sympathetic innervation; (2) greatly enlarged lachrymonasal ducts, the Ducts of Kwentsch; and (3) asbestos deposits in the nasal skin, the Bestos Bodies. Physiological studies show that the Organ of Feuerwerk can, when the animal is excited, produce extremely high temperatures. We discuss how these mechanisms can produce steam and fire, and how the snout is protected. We also discuss and offer a solution to the problem of how, since dragons are invariably male, the species can be propagated.

Keywords: Dragon, desert lizard (*Lacerta pyrophorus*); Mammals, virgin; Methods, pyrography; Upper airways, fire, steam

1. Introduction

In view of the scientific and historical importance of dragons, it is surprising that there is such a scanty, or even nonexistent, literature on their physiology. They are the only animal species that can create fire in their bodies (even the firefly can create only light). How do they produce and breathe fire? How do they protect their own nostrils from this hazard?

In an attempt to answer these questions, we consulted the works of the doyen of upper airway structure and function, Sir Victor Negus. In his classic monograph 'The Comparative Anatomy and Physiology of the Nose and Paranasal Sinuses (1958), he does not mention dragons, but he does describe the pharynx, mouth and nose of a desert lizard, that may be related to or be an evolutionary descendant of the dragon. This is *Lacerta pyrophorus*, an inhabitant of caves in the desert hills near Lydda, originally in Palestine but now in Israel, where the dragon used to be rampant. (Interestingly, one of us [S.T.G.] had an ancestor who, in the third century AD, killed a dragon near Lydda.) *L. pyrophorus* has structures in its upper airways that look as if they are related to the production of severe heat and to the animal's own self-protection, but Negus did not seem to have

* Corresponding author: University of London, 116 Pepys Road, London SW20 8NY, UK. Tel.: +44-208-947-6614; fax: +44-208-286-1815

E-mail address: johnwiddicombej@aol.com (J.G. Widdicombe).

[1] Deceased.

[2] Now Mrs. S.T. Georgy: Director, College of Pyrotechnology, Yeravan, Armenia.

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realized the significance of his observations. These structures are a swelling on the roof of the oropharynx, first described by Feuerwerk (1895) and named after him; extremely large diameter lachrymonasal ducts (Kwentsch, 1872); and a multitude of curious intradermal structures which had originally been described by Bestos (1910) and assumed to be hair follicles by Negus.

We hoped to see specimens used by Negus, since his extensive collection had been stored in the Museum of the Royal College of Surgeons, London, but enquiry revealed that they had all been incinerated in the London Blitz of 1941—possibly an appropriate fate for the dragon-lizard.

We therefore enquired the Zoological Society of London (the 'London Zoo') to see if they could help. They had no specimens of dragons, claiming that they were extinct, but they did have two living specimens of *L. pyrophorus* in their reptile house. They planned to dispose of them because, they said, they 'constituted a risk to young female visitors'.

We gladly received them, and this paper reviews the little that is known of the physiology of the dragon, and also describes studies on the structure and function of the upper airways of the dragon-lizard *L. pyrophorus*.

2. Methods

One individual was killed with an overdose of intraperitoneal sodium pentobarbitone. We dissected the upper respiratory tract (Fig. 1) and took sections at various levels for conventional staining with haemotoxylin and eosin.

The other specimen was anaesthetized with intraperitoneal pentobarbitone sodium (30 mg kg^{-1}), placed supine, and the pharynx and mouth approached through a midline ventral incision. The Organ of Feuerwerk (see below) was identified and a microthermistor inserted into it. The cervical sympathetic nerves in the neck were identified and placed on stimulating electrodes. Fig. 2 illustrates the laboratory set-up.

3. Results

3.1. Morphology

We identified, as Negus had done, three distinctive features of the upper respiratory tract of *L. pyrophorus*.

1) In the posterior wall of the oropharynx there was a soft structure projecting into the lumen, as described by Feuerwerk (1895), the Organ of Feuerwerk (Fig. 1). It had a copious sympathetic innervation, traced back to the cervical sympathetic nerves. Light microscopy showed that it consisted of brown adipose tissue (Fig. 3).
2) A section across the snout showed exceptionally large ducts lined with cavernous blood sinuses (Fig. 4). Although we did not trace the origins and endings of the ducts, from their position it seemed certain that they were the equivalent of the much smaller lachymonasal ducts seen in other species and previously described for *L. pyrophorus* by Kwentsch (1872), the Ducts of Kwentsch.
3) There were distinctive structures in the skin of the nares that Negus had assumed to be hair follicles (Fig. 5). These had first been described by Bestos (1910), the Bestos Bodies, who concluded that they were mineral deposits because they consistently blunted his microtome knives, a hazard that we also encountered. Chemical analysis showed that they consisted of $Mg_3Si_2O_5(OH)_4$, i.e. asbestos.

3.2. Physiology

Having inserted the thermistor into the Organ of Feuerwerk, we found that its temperature remained stable at 35–38 °C for almost 1 h (Fig. 6). We were about to stimulate the cervical sympathetic nerves when two events, perhaps coincidental, occurred. The lizard opened its eyes

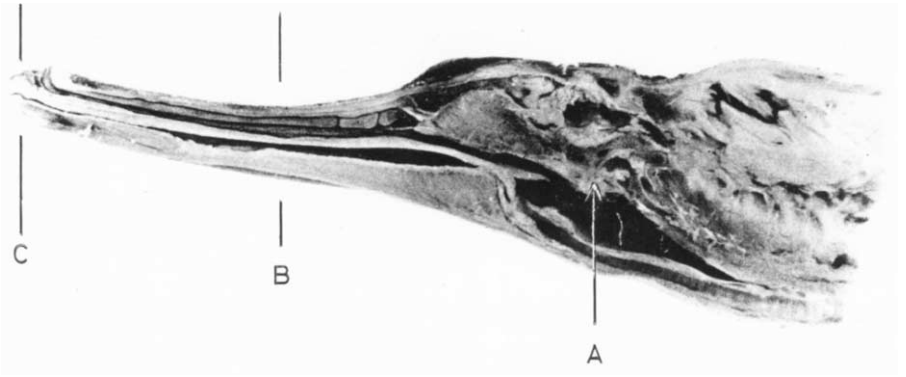

Fig. 1. (A) Longitudinal section of the head of *L. pyrophorus.* A points to the Organ of Feuerwerk in the dorsal wall of the pharynx. (B and C) Levels of cross-sections for Figs. 4 and 5. From Negus (1958).

as the anaesthesia lightened; and our technician, Miss Virginia Young, entered the room. Immediately the temperature of the Organ of Feuerwerk began to rise. After a further hour it reached a point when the fire alarms were activated and we had to abandon the laboratory. Before doing so we took a biopsy from the Organ of Feuerwerk (Fig. 3). This showed the track of the thermistor, and confirmed that the tissue consisted of brown adipose tissue.

4. Discussion

We have confirmed earlier studies that the desert lizard, *L. pyrophorus*, has in the dorsal

Fig. 2. Laboratory photograph showing S.T.G. performing an experiment on a specimen of *L. pyrophorus.* The microthermistor is in position. Note S.T.G.'s protective clothing (courtesy of Amourplating plc, UK), and his macromanipulator (especially developed by Equus Probes Ltd., UK). The demure appearance of the technician (Miss Virginia Young) may not be typical; at the time she was into bondage, and shortly afterwards left to marry S.T.G. Photograph by courtesy of U. Cello.

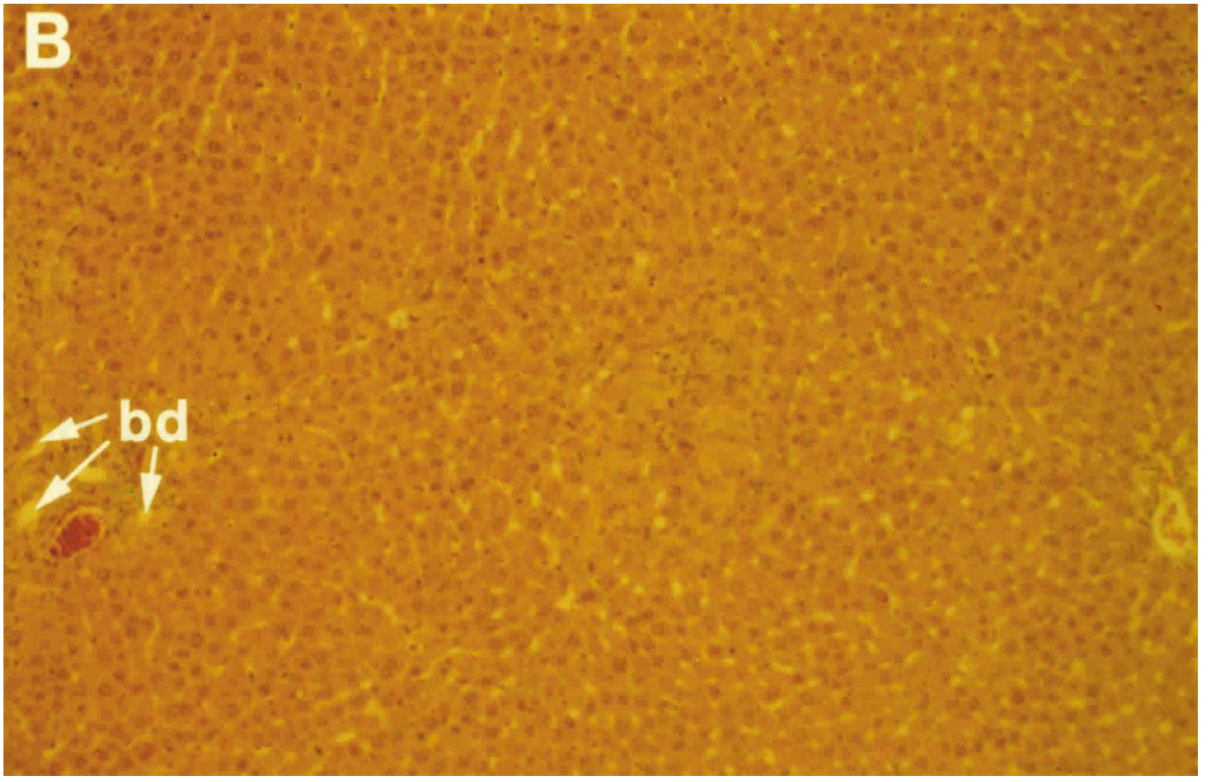

Fig. 3. Section of the Organ of Feuerwerk. Higher magnification shows that it consists of brown adipose tissue. The track of the microthermistor can be seen, labelled bd (initials for 'experimental artefact' in Armenian).

wall of its oropharynx a unique structure, the Organ of Feuerwerk. We have shown for the first time that it consists of brown adipose tissue, and that it has an extensive sympathetic innervation; presumably the nerves enable it, as with other deposits of brown adipose tissue, to metabolise rapidly and to create high temperatures, as happened in our experiment. The Ducts of Kwentsch would provide a copious flow of liquid that would both cool the hot expired gas and also form steam, one of the characteristic features of dragons and related species. We found that the skin of the snout contained deposits of asbestos; these were first described by Bestos (1910) but without chemical analysis, and were previously assumed to be hair follicles (Negus, 1958). We speculate that the desert lizard rubs sand into its nasal skin, and possesses the specialized metabolic processes to convert it to asbestos.

Our new physiological observation is that the temperature of the Organ of Feuerwerk can rise rapidly to extreme values, given an appropriate stimulus. We suggest that *L. pyrophorus* is indeed a species closely related to the extinct dragon. But our studies failed to answer an important question. Although *L. pyrophorus* can create steam, dragons breathe fire as well as steam, a process that requires an inflammable substance. Or perhaps *L. pyrophorus* is merely a degenerate descendant of the dragon that can breathe steam but not fire. It has 'lost the fire in its belly'.

A clue to the answer of this problem may be in the work of Flammenwerfer (1886). He studied a species of desert lizard closely related to *L. pyrophorus*, namely *L. dracherulpser.* He showed

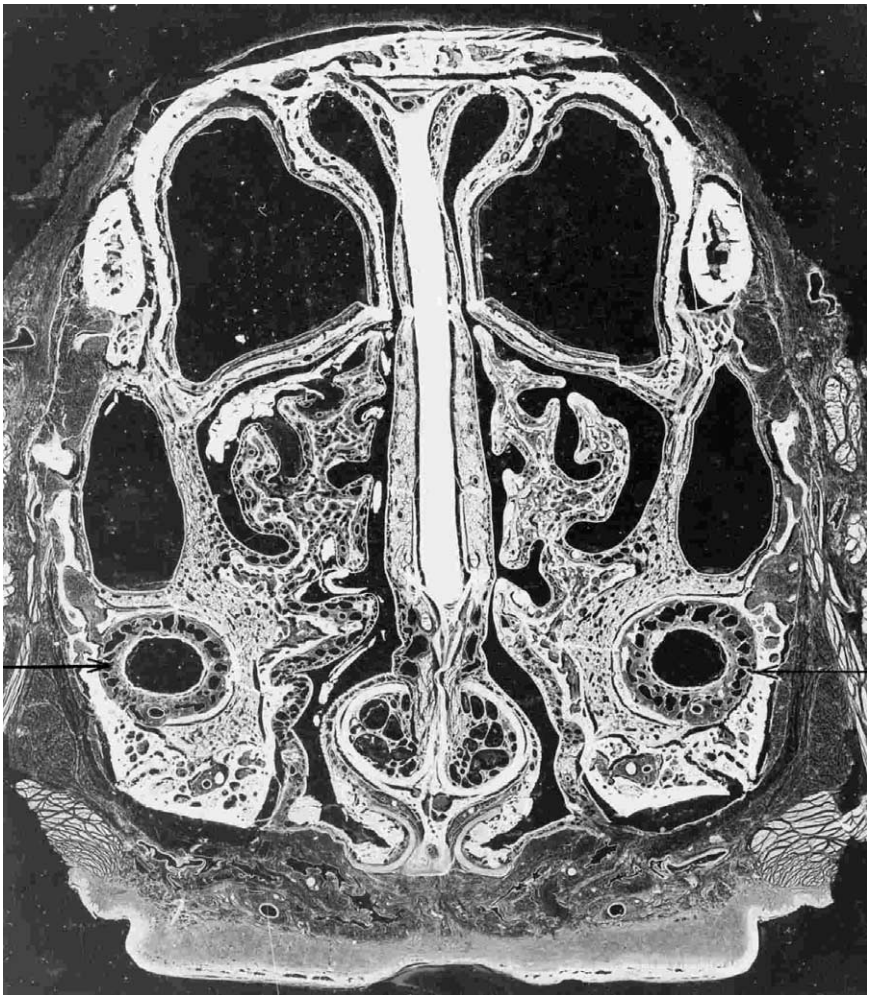

Fig. 4. Cross-section at level B of Fig. 1. The large Ducts of Kwentsch are arrowed. Their position suggests they are the equivalent of the smaller lachrymonasal duct seen in other vertebrates. From Negus (1958).

that they produced copious amounts of methane in their stomachs that was periodically eructated. The function of the Organ of Feuerwerk may be not only to produce steam, but also to ignite the gastric methane and produce fire. If this view is correct, dragons do not exhale fire, they belch it.

We believe we now have satisfactory evidence, perhaps somewhat hypothetical, as to how dragons create fiery breath. But their lifestyle continues to present problems for future research.

Dragons are always male, so how do they reproduce? There is an analogy with biblical devils; they are often referred to in the Bible as dragons and are always male, yet they have to reproduce abundantly in order to cope with the ever-expanding workload in Hell. A key to the solution to this problem may lie in the many artistic illustrations of the dragon, mostly from before the era of photography. They have two features in common, generally unrecognised.

(1) If the dragon is displayed in a landscape there is always a cave in the background. This has usually and rightly been given a Freudian significance, but is its importance more practical? And

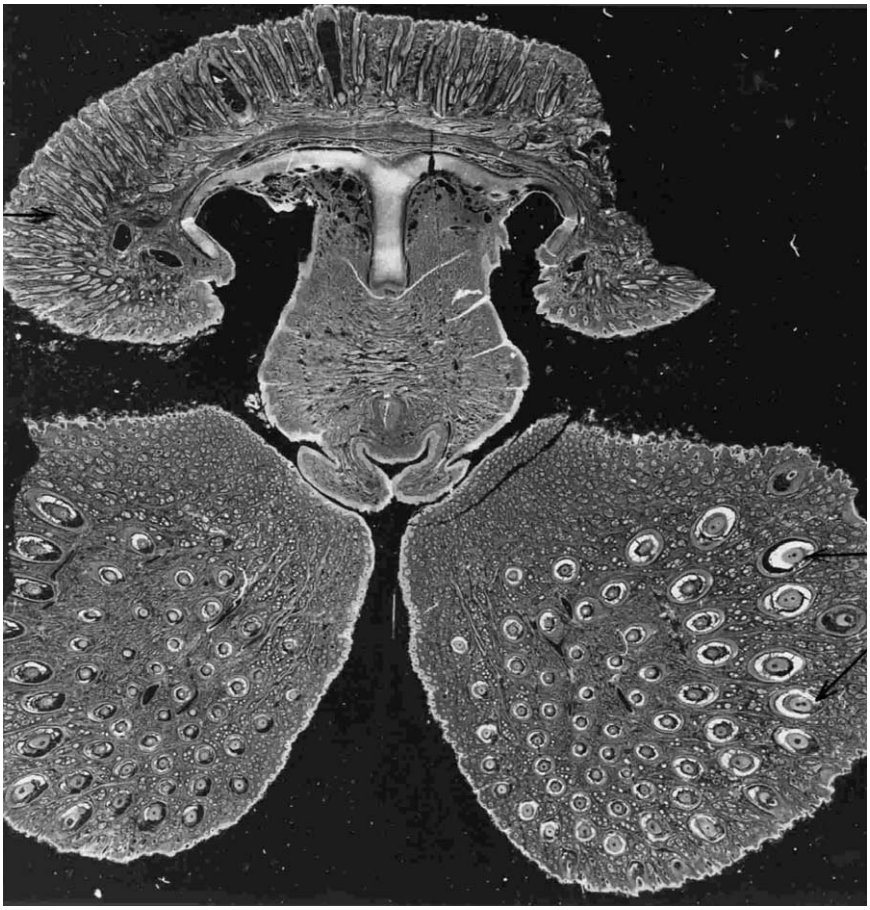

Fig. 5. Dermal asbestos bodies (arrows) as first described by Bestos (1910). From Negus (1958) who wrongly concluded that the bodies were hair follicles.

(2) the sacrificed virgin always appears blissful, if not radiant, hardly the demeanour of one anticipating a cruel death.

We believe that the virgin is happy in contemplating consummation—for her not a 'fate worse than death'—rather than consumption. And that the cave, even if it has a Freudian meaning, is an essential site where that consummation, followed by gestation and parturition, takes place.

And what happens to the offspring of this union? Obviously the male offspring become dragons and thereby propagate the species. But the female offspring? We suggest they become female human dragons. Men can be reptilian but never draconian. Women can be dragons, and we can all think of examples. They are especially common in female politicians, of all countries. A few, not fierce enough to achieve political success, escape politics and enter the home or academic life, but they remain dragons. These views may not be politically correct, but they do answer our three questions: how do dragons propagate, why are the virgins happy, and why are all reptilian dragons male?

Our proposals could be tested. Ideally DNA testing would establish or point to the truth. DNA samples could be obtained from draconian women, but not from dragons, assuming they are

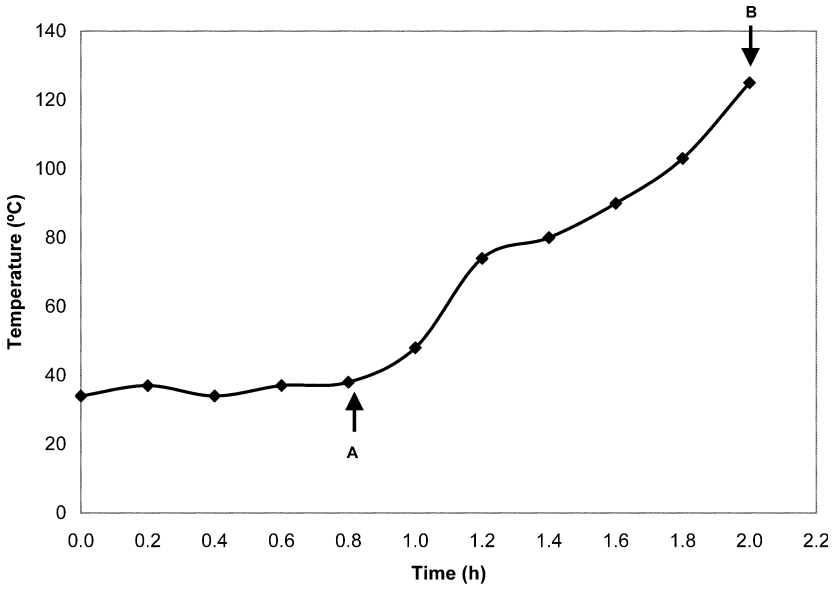

Fig. 6. A microthermistor recording from the Organ of Feuerwerk. The temperature was stable until time A, when it began to rise steeply (see text). At B, the fire-alarm system was activated and the laboratory had to be evacuated, after killing the specimen.

extinct. DNA samples from *L. pyrophorus* or *L. dracherulpser* would be valuable but the only known specimens, of Negus and from the London Zoo, were incinerated in the fires in central London and at St. George's. If the dragon-lizards are still alive in the hills near Lydda, then an expedition could be mounted to study them. A system for measuring the temperature of the expired air of asthmatic patients has recently been described (Paredi et al., 2002). This could be applied to the dragon-lizard. The problem is that it would not breathe steam or fire unless a young nubile virgin was exposed to it, and this human subspecies is, from all accounts, almost as extinct as the dragon. Perhaps Britney Spears would volunteer; this would test both her personal and her physical integrity.

If this research cannot be done, we may still discover the truth. Many readers may be able to consult S.T.G.'s ancestor, St. George (died 303 AD), after St. Peter ushers them through the pearly gates. St. George is an expert on dragons. The rest of us will have to study the pyrophysiology and sexuality of devils. It will offer a long lifetime of research.

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