FUNCTIONAL MORPHOLOGY OF THE NEMATODE PHARYNX.
II. SPHERICAL BULBS

BY

D. R. ROGGEN
Eenheid Dierkunde, Vrije Universiteit Brussel, Pleinlaan 2, B-1050 Brussel, België

In a first model the relation between the relative dimensions and the function of a cylindrical pharynx is investigated, taking *Ascaris* as a starting point. Next, the conditions necessary for a valid comparison between a cylindrical pharynx and a spherical bulb are determined. In a second model the functional possibilities of a spherical bulb are determined and it is concluded that a terminal spherical bulb produces more pressure, but less suction, than a comparable cylindrical pharynx.

It is the purpose of this work to develop a simple theoretical model of a pharynx with a terminal spherical bulb and to compare its functional possibilities with those of a cylindrical pharynx. *Ascaris* will be used as a basis for extrapolation.

*Extrapolations from Ascaris*

When a nematode feeds it sucks in a certain volume of food from its environment and injects it into its gut. This means that the following parameters are sufficient for the description of the function of the pharynx:

- The volume of the food-filled lumen $\Delta V$
- The suction pressure $P_S$
- The injection pressure, which is equal to the pressure developed in the pharynx wall $\Delta P$.

All nematodes are assumed here to have the same body pressure $P_B$ (see Harris & Crofton, 1957) of value unity.

The transmural pressure at the lumen wall is

$$PT = P_B + \Delta P + P_S$$

Maximum values observed or calculated for *Ascaris* are taken as a basis for comparison (Harris & Crofton, 1957; Roggen, 1973):

$$P_B = 1.35 \times 10^4 \text{ Pa};$$
$$P = 2.15 \times 10^4 \text{ Pa};$$
$$P_S = 0.1 \times 10^4 \text{ Pa};$$
$$PT = 3.60 \times 10^4 \text{ Pa}.$$
relative shortening of the muscles, and this can be determined if the geometry of
the pharynx is known. For simplicity I will consider only a muscle fiber which
extends radially from the midpoint of a sector, i.e. the muscle with the largest
relative shortening. At rest, when the lumen is closed, the resting length of the
muscle $LO$ equals $RC$, the radius of the cylindrical pharynx.

When the lumen is completely open and has a circular cross-section, the length
of the shortened muscle $LS = R'C - rC$, with $R'C$ = radius of the pharynx when
the lumen is open and $rC =$ radius of the cylindrical lumen. Since the volume of
the pharynx wall is constant,

$$\pi (R'C^2 - rC^2) = \pi RC^2$$

and

$$R'C^2 = RC^2 + rC^2$$

Putting $rC = KC RC$

$$0 \leq KC \leq 1$$

we find

$$LS = RC \sqrt{1 + KC^2} - KC RC$$

and the relative shortening becomes:

$$\left(\frac{\Delta L}{LO}\right)_{c} = \left(\frac{LO - LS}{LO}\right)_{c} = 1 + KC - \sqrt{1 + KC^2}$$

For *Ascaris* $KC = 0.6$ and $\left(\frac{\Delta L}{LO}\right)_{c} = 0.434$.

Assuming a linear relationship between $\frac{\Delta L}{LO}$ and the muscular tension $TM$
(Ackerman, 1962):

$$TM = a \frac{\Delta L}{LO} + b$$

Knowing that the value for *Ascaris* is 0.434, taking the maximal tension, when
$\Delta L = 0$, as $5 \times 10^5$ Nm$^{-2}$ (Roggen, 1973), and taking $PB = 1.35 \times 10^4$ Pa
as unity one arrives at

$$TM = 37 -- 83 \frac{\Delta L}{LO}$$

for the linear relationship between tension and relative shortening in the pharynx
muscles of *Ascaris*.

What happens when all factors except $KC$ are kept constant and $KC$ is varied
between 0.6 (*Ascaris*) and 0?

The relative volume of the lumen varies with $KC$:

$$\frac{\Delta VC}{VC} = \frac{\pi rC^2 L}{\pi RC^2 L} = KC^2$$

where $L$ = length of the cylinder.