THE PHARYNX AND ALIMENTARY CANAL OF THE
HOOKWORM Larva—NECATOR AMERICANUS¹

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The following facts, based on observations recently made by the writer
(Pl. 1), may be given as reasons for regarding the pharynx of the full-
grown larva of Necator americanus as somewhat in the nature of a pro-
trusile onchium:

(1) The apex of the pharynx (on) in different specimens, fixed and
living, varies in position from considerably behind the amphids to a
slight protrusion beyond the lips.

(2) The form of the pharynx reminds one of the protrusile onchium
of Mermis.

(3) The pharyngeal wall is of considerable thickness, such as would
impart to it the rigidity necessary for puncturing, while the lumen is
very narrow, as in many Tylenchus, “spear-bearing” nemas characterized
by the possession of an onchium presumably evolved through conversion
of a thin-walled cylindroid or prismoid pharynx into a relatively thick
walled, tubular, protrusile spear.

(4) Round the front portion of the pharynx is a refractive ringlike
element (dir on) similar to that found in nemas armed with a protrusile
spear. This encircling element in such cases serves as a guide for the
spear when in action. The location, form, and size of this element in
Necator larvae harmonizes well with the supposition that the associated
“onchium” is protrusile; its position accords with the limits of longitudi-
nal motion apparently justly attributable to the “onchium” on the basis
of observations made on a considerable number of specimens.

(5) The front part of the pharynx is surrounded (?) by tissue readily
explainable as contractile, (msc?) similar to that seen in nemas having
a protrusile onchium. Such muscles are usually attached to the posterior
part of the onchium and to the labial cutin.

(6) The oesophagus of the Necator larva contains “salivary” glands
emptying precisely as in a large number of well known nemas possessing
a protrusile onchium, namely, three unicellular oesophageal glands having
their nuclei located in the posterior oesophageal swelling and emptying
forward through three separate ducts, two emptying into the lumen of
the oesophagus near its middle, and the third extending farther forward in
the dorsal sector of the oesophagus and emptying at the base of the
onchium (gl sal dst).

(7) Considered in the light of the known entrance of hookworm larvae
into the human host through the skin, these pharyngeal and oesophageal
elements fall into a harmonious group in accord with the proposal that
the pharynx when acting as a mechanical puncturing organ is assisted by
the oesophageal fluid, acting as a solvent, in forcing a passage through
the skin.

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A prominent symptom connected with the penetration of hookworm larvae into the human skin is an itching sensation lasting several days. It seems quite as likely that this irritation is caused by a secretion of the larva as by its motions. Reflecting that the "bite" of many insects often, at the time, is accompanied by very little sensation of any kind, while the wound after the withdrawal of the insect's mouth parts becomes inflamed, it is an obvious inference that some substance injected into the wound causes the inflammation rather than the puncture itself. This line of observation and reasoning is in harmony with the supposition that *Necator americanus* works its way through the human cuticle partly by the aid of a solvent, which, incidentally, may account for the accompanying symptoms.

The fact that this onchium of *Necator* larvae has never been seen in action, that is, has never been seen to move in living larvae under the microscope, throws little, if any, doubt on its being protrusile, for it is well established that the examination even of thousands of specimens of nemas of various kinds possessing a protrusile spear may not enable one to make such a direct observation. It is only on rare occasions that the protrusile onchium of a nema has been seen in action, the commonest occasion being its use by the larva in escaping from the egg. Here the larva, even under the blaze and other inhibiting conditions of the microscope, sometimes remains in condition to proceed with its operations. However, many thousands of observations made by numerous competent observers, using hundreds of different species of nemas possessing a protrusile onchium, has resulted in accumulating circumstantial evidence so strong as practically to prove, in this way alone, even unsupported by other evidence, that the onchium is protrusile. This circumstantial evidence, as in the case of *Necator*, relates very largely to differences in the observed position of the onchium, but also relates to its form. On such evidence alone belief that the onchium is protrusile is practically unavoidable, since no other explanation of its form or function can reasonably be offered.

These various considerations appear to me to make it at the very least a reasonable working hypothesis that the pharynx of *Necator americanus*, at the time it reaches the condition of the "full grown larva," is modified into what may fairly be regarded as a protrusile organ.

Interesting morphological speculations with regard to nema anatomy are associated with such an hypothesis. The young larva of *Necator americanus* is said to be rhabditiform. Now there are certain nema genera in which the rhabditoid form of pharynx, when the species are assembled and suitably arranged, may be "traced" step by step to a pharynx similar to that of *Tylenchus*, a well known genus containing both free-living and parasitic nemas and possessing a protrusile onchium used for piercing, and this fact has led to the promulgation by Marcinowski of a theory that the tylenchoid pharynx may have been evolved from the rhabditoid pharynx.

**THE AMPHIDS OF NECATOR**

The writer's observations on the amphids on *Necator americanus* (*amph*) are not subject to the qualifications necessary in the case of the pharynx. That these organs on the front of the head of *Necator* fall into the group of organs known as amphids seems to me beyond question. Their number, form, exact symmetry, position, and structure are those typical of well known amphids. The nature of the amphidial
terminals (presumably nerve endings), arranged symmetrically on opposite sides of the head within the amphids (frm), lead to the belief that the backward processes connected with them pass to the nerve ring, although they have not been traced thither. It would be an interesting piece of work to trace them backward by means of serial sections of the adult nema.

The cells of the intestine throughout its length, and some of the cells of the body wall, are well stocked, in the young larva, with fat globules. These darken in osmic acid, those in the body wall apparently more vigorously than those in the cells of the intestine, a difference that may be connected with the relative position of the two groups of globules.
At right and left, dorsal and lateral views of the head of *Necator americanus* free-living larvae when full grown; between them the front view of the head and an optical section near the line AA; ppl, one of the four labial submedian papillae; on, onchium or pharynx; oe, oesophagus; gl sl sl, dorsal oesophageal gland; chr sl sl, dorsal chord; amph, amphid; amp, ampulla of the dorsal oesophageal gland; ph, pharynx; os gl, dorsal oesophageal gland emptying into the lumen of the oesophagus or pharynx; msc?, contractile fibers(?); dir on, guiding ring encircling the anterior portion of the pharynx; trm amph, terminals in the amphid, presumably the end elements of nerve fibers; sal, dorsal oesophageal gland; nrv, and opposite AA, nerve passing to one of the submedian labial papillae; lum oe, lumen of the oesophagus. The dorsal and lateral sketches were made from living specimens, the front view and section from specimens fixed in Flemming's solution and mounted in glycerin jelly.

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