NEODIPLOGASTER PINICOLA, N. SP., A NEMA ASSOCIATED WITH THE WHITE-PINE WEEVIL IN TERMINAL SHOOTS OF THE WHITE PINE

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INTRODUCTION

Fuchs (4) in 1915 first called attention to the fact that the moist frass of the mines produced by Ips typographus and Hylotrupes abietis is inhabited by a specific nemic fauna, the members of which are in more or less close symbiotic relationship with the beetles. He observed that some of the nemas were carried about by the beetles, either under the wing covers or in some other way. In some instances the relationship between nemas and beetles seemed to be more or less that of parasite and host. Fuchs also mentioned the fact that different genera and species of beetles have different nemas as their associates. Similar observations were published more recently by Jazentkovsky (5).

Previous to the present paper, so far as the writer is aware, no case of the association of a nema with the white-pine beetle (Pissodes strobi) has been recorded.

In June, 1928, R. L. Taylor, of the Bussey Institution for Research in Applied Biology, Harvard University, sent the writer terminal shoots of the white pine (Pinus strobus) affected by Pissodes strobi and harboring numerous nemas in the mines. Doctor Taylor at that time suggested that probably the same nemas also occur under the wing covers of the beetles. Further material for study was then received from Maine through the courtesy of E. G. Arzberger. As far as the writer could see, the mines of P. strobi harbor only one species of nema, which, however, is new and belongs to the genus Neodiplogaster Cobb (2).

RELATIONSHIPS OF GENUS NEODIPLOGASTER

Neodiplogaster is closely related to the genus Diplogasteroides of De Man (6) and also to the genus Rhabditolaimus established by Fuchs (4) for forms that he found in the mines of the bark beetles of Europe. Only one species of Neodiplogaster is known at present—N. tropica which Cobb (2) found in coco pods from Guatemala. The status of the genus at that time was still somewhat doubted by its author. After making a study of the present form, the writer considers Neodiplogaster a good genus. Its relationship to the other genera of the Diplogasteridae is best shown by a summary of the diagnostic characters of the various genera:

DIPLOGASTEROIDES (De Man, 6).—Diplogasteridae with a cylindrical undivided pharynx, at the base of which is a small dorsal tooth; male tail with numerous papillae but no bursal structures.

1 Received for publication Mar. 18, 1930; issued July, 1930.
2 Reference is made by number (italic) to Literature Cited, p. 129.
Rhabditolaimus (Fuchs, 4).—Diplogasteridae similar to Diplogasteroidea, but with the pharynx unarmed; male tail with small bursal membranes.

Neodiplogaster (Cobb, 2).—Diplogasteridae with the pharynx divided into a short but wide anterior section and a longer cylindrical posterior section; on the bottom of the anterior part a single well-developed dorsal tooth; on the bottom of the posterior part two sub-dorsal cuticularized oval pieces. Male tail with numerous papillae partly connected by more or less developed bursal structures.

Demaniella (Steiner, 10).—Diplogasteridae with cylindrical undivided pharynx, at the bottom of which is a large dorsal tooth; anterior esophageal bulb elongated; oral opening with conical elevation and surrounded by a number of semicircular cuticular thickenings.

Odontopharynx (De Man, 7).—Diplogasteridae with irregularly shaped, wide, deep, armed pharynx; anterior part of esophagus without distinct bulb but its lumen throughout its entire length with highly cuticularized walls, and the esophageal tissue with strong radial muscles. Male tail with numerous papillae but no bursal structures.

CLASSIFICATION OF THE DIPLOGASTERIDAE

As against Baylis and Daubney (1, p. 41-42, 109-110), the writer holds the opinion that Diplogaster, Rhabditolaimus, Odontopharynx, Demaniella, Neodiplogaster, and Diplogasteroidea are good genera, each including perhaps a number of species. They form a natural family (the Diplogasteridae), in which the structure of the posterior part of the esophagus is the chief distinguishing characteristic. Rhabditolaimus and Diplogasteroidea, which are among those genera of the Diplogasteridae that show a definite relationship to the genus Rhabditis (family Rhabditidae), have the typical diplogastroid esophagus—that is to say, the terminal bulb is without radial muscle fibers and has no valvular apparatus.

The subgenus Rhabditella, of the genus Rhabditis, may be considered a connecting link between Rhabditolaimus and Diplogasteroidea on the one hand and Rhabditis on the other, for in Rhabditella the male tail end very closely resembles that of either of the two diplogastroid genera. Rhabditella is nevertheless clearly distinguished from both of these Diplogasteridae by the shape of the posterior part of the esophagus, the terminal bulb of which has a definite valvular apparatus.

The Diplogasteridae possess additional distinguishing characters in the male copulatory apparatus with its spicula and gubernaculum and in the arrangement and shape of the papillae. The papillae, however, are sometimes supporting membranes of bursal character, thus clearly showing a relationship to Rhabditella. Moreover, in some forms (Diplogasteroidea, Rhabditolaimus, etc.) the pharynx exhibits a close relationship to the typical Rhabditis pharynx.

The present classification of the Diplogasteridae is not considered as final. Cobb (3) has already called attention to the fact that the forms at present included in the genus Diplogaster represent various groups with distinct characters. The writer is convinced that in the near future these groups will be definitely separated into different genera.
HABITS OF THE WHITE-PINE WEEVIL

The white-pine weevil, *Pissodes strobi*, occurs wherever the white pine grows, but is economically important in only a part of the range of the white pine. Its principal damage is produced on this plant, although a few others like *Pinus rigida* (pitch pine), *Picea rubra* (red spruce), *P. abies* L. (Norway spruce), *Abies balsamea* L. (balsam fir), and *Tsuga canadensis* L. (hemlock) may also be attacked. The beetle causes in the pine the abnormal development that is called "cabbage" or "pasture" pine. It attacks the terminal shoots of the host plants, killing them off; new leading shoots may then be developed and in turn killed, the result being that often a large number of new terminal shoots are formed which give the host plant the forked and crooked aspect previously mentioned.

The white-pine weevil lays its eggs in small holes that it makes in the topmost shoot of the previous year's growth. A number of eggs are usually deposited in one hole, and the newly hatched larvae gnaw small mines in the tissue below the bark. Usually only some of the eggs develop, and the mortality of the larvae is very high, presumably from starvation or parasitism. The mature larvae bore into the wood parenchyma and pupate. The adults emerge in the latter part of August or still later and are supposed to hibernate in the ground (Peirson, 9).

NEODIPLOGASTER PINÍCOLA N. SP.

ECONOMIC IMPORTANCE

The life cycle of the nema observed by the writer as a parasite of the white-pine weevil is not yet known, but the fact is established that the adult beetle carries specimens of the nema under its wing covers, and only by this fact can the presence of the nema in all the mines examined be understood. It is considered probable that when the beetle deposits its eggs some of the nemas slip out from under the wing covers and remain with the eggs in the new mine.

Here, perhaps, the nema comes in as a control factor of economic value by causing the high mortality in the eggs and young beetle larvae previously mentioned, although this has not yet been verified by observation or experiment. Diplogaster species, however, have been observed feeding on grasshopper eggs (Merrill and Ford, 8, p. 124). This fact and observations on other Diplogasteridae suggest the possibility that the present form may feed on the eggs of the beetles.

TECHNICAL DESCRIPTION

*Neodiplogaster pinícola*, n. sp.

*Neodiplogaster pinícola* (fig. 1) is slender and of small size, not quite 1 mm. in length. The tail end of the larva end of the female is long-conical and sharply pointed. That of the male is much shorter but also conical and pointed. The cuticle is annulated, but with high magnification the annulation is resolved into series of transverse and longitudinal dots. These dots are more distinct on the lateral surface, especially at the tail end. Figure 1, F, gives a view of the arrangement of these dots. A wide undotted space always separates a double longitudinal series of dots except along the lateral line where four such series of dots are close together. (Fig. 1, F.) If, however, these series of dots are analyzed, it can be seen at once that groups of four dots alternate with groups of only two, which are placed in a transverse direction. This arrangement gives the surface a very specific character. The head end is not set off; its shape is convex-conoid.
FIGURE 1.—Neodiplogaster pinicola, n. sp. A, Anterior end; ant blb, anterior esophageal bulb; nre r, nervous ring; p ex, porus excretorius; post blb, posterior esophageal bulb. × about 700. B, Lateral view of head end; bas knots, cuticularized dorso-sublateral basal knots of pharynx; dsl dnt, dorsal onchium; lat ppl, lateral papilla. × about 1,433. C, Medial view of head end; bas knots, cuticularized dorso-sublateral basal knots of pharynx; amph, amphid. × about 1,433. D, Front view of head. × about 1,433. E, Cross section in region of basal knots of pharynx. × about 1,433. F, Arrangement of dots on cuticle. G, Tail end of female. × about 700. H, Lateral view of male tail end; brs msc, bursal muscles; 1-9, male copulatory papillae. × about 700. I, Ventral view of male tail end. × about 700
circle of six papillae is present. The amphids are very inconspicuous and open behind the middle of the pharynx. The latter is separated into two parts, a wide but shorter anterior one, which is striated longitudinally, and a narrow but longer posterior one. At the base of the anterior portion of the pharynx a single dorsal tooth is seen; it is quite conspicuous and curves forward. The second part of the pharynx is narrower but much longer and of somewhat cylindrical shape. Its shape in cross section was not made out. Two ellipsoidal cuticularized structures are seen at the base of this pharyngeal section, much as in Neodiplogaster tropica; they seem not to protrude into the pharyngeal cavity but to be located in the surrounding tissue in a somewhat dorso-sublateral position. (Fig. 1, A, B, C, E.) Their significance is not clear. The esophagus is of typical diplogastroid shape. As can be seen in Figure 1, A, the anterior esophageal bulb is very well developed. The male sexual apparatus has a single testis, outstretched forward. The bursal muscles are strongly developed, eight pairs being located in front of the anus and two behind it. The spicula are arcuate, exceedingly slender; the proximal ends are cephalated, the distal ends sharply pointed. The gubernaculum completely surrounds the spicula; it is of very complicated structure, as may be seen in Figure 1, H, I. A series of about nine ventro-submedial papillae was seen on each side of the male tail. The arrangement is very specific and furnishes an outstanding differentiating feature between Neodiplogaster tropica and the present species. The first papilla is near the middle of the spicula, the second is just in front of the anus, the third just behind it. These three papillae are not of identical size, the first one being larger than the other two. A fourth papilla is located ventro-submedially just behind the middle of the tail; it seems to support a small membranous structure, a kind of miniature bursa. A series of four much smaller papillae is seen in front of the tail end, close to the ventro-medial line. The ninth papilla, however, has a dorso-submedial position a short distance in front of the tail end. The female reproduction apparatus is amphidelph and the ovaries are reflexed. The vulva opens just behind the middle of the body.

**Measurements:**

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**Diagnosis of the New Species:** Neodiplogaster differing from Neodiplogaster tropica mainly in the different arrangement of the male copulatory papillae, in the much more reduced bursa, and in the presence of a dorso-submedial papilla close to the end of the male tail. Wall of anterior portion of pharynx with longitudinal striae.

**SUMMARY**

A new nema, Neodiplogaster pinicola, n. sp., is described, and the affinities of this and other genera of the Diplogasteridae are reviewed. The present form was found living in the moist frass of mines produced by Pissodes strobi, the white-pine weevil, in terminal shoots of the white pine (Pinus strobus). It is suggested that this nema may be of economic importance as an enemy of its host, on the eggs and larvae of which it probably preys.

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