HETERAKIS TRAGOPANIS, A NEW SPECIES OF THE GENUS HETERAKIS FROM THE INTESTINE OF A CRIMSON-HORNED PHEASANT

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A LARGE number of these parasites were recovered[1] from the intestine of a crimson-horned pheasant, *Tragopan satyra* which died at the Prince of Wales Zoological Gardens in Lucknow.

Male.—Length about 8·0 mm.; maximum breadth 0·3 mm.; feeble lateral alæ present. Caudal alæ broad and well developed and tend to unite across the ventral surface, a little anterior to the pre-cloacal sucker. Pharynx and œsophagus including the bulb measure 1·05 mm. Œsophageal bulb is 0·25 mm. long and 0·2 mm. broad. Tail of the male is 0·51 mm. long. Pre-cloacal sucker lies at a distance of 0·16 mm. from cloacal aperture. The sucker is thickly chitinised around its margin. The chitin is specially thickened at the middle of the anterior and posterior border of the sucker and appears to project out like two teeth perpendicular to the margin of the sucker. The sucker measures 0·07 mm. × 0·04 mm. in cross axes. There are eleven paired caudal papillæ and one single median papilla. There are two pairs of long peduncled papillæ lying by the lateral sides of the pre-cloacal sucker besides a median short peduncled papilla which lies on the posterior border of the sucker. There are six pairs of papillæ around the cloacal aperture;
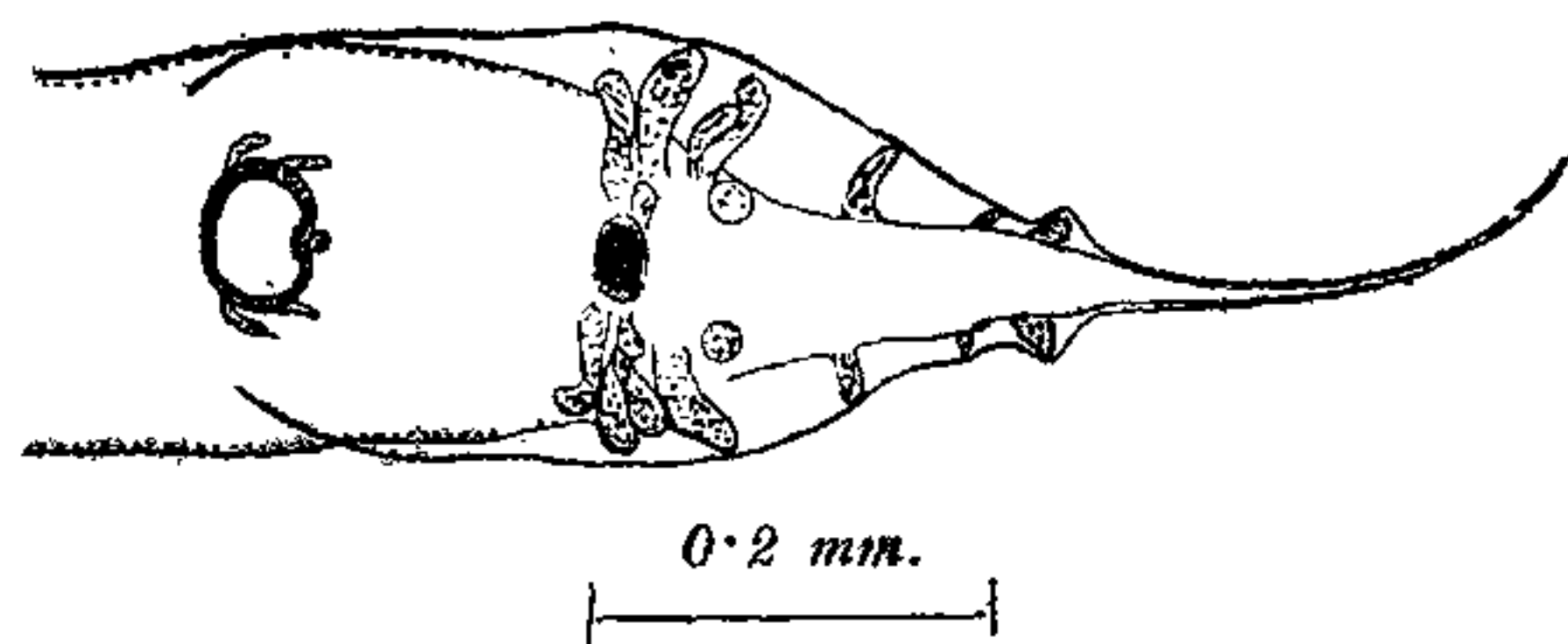

0·2 mm.

FIG. 1

Heterakis tragopanis (male), posterior end—ventral view showing arrangement of papillæ

four pairs of these have extremely long peduncles and extend into the alar projections. The remaining two pairs are small; the one by the side of the cloacal aperture has a short peduncle and the other situated a little posterior to it appears to be sessile and is rounded in shape. Posterior to these papillæ and post-cloacol in position lie three pairs of peduncled papillæ. These project into the alar membrane; the one proximal to the cloacal group of papillæ is larger than the two distal ones. The spicules are almost equal in size, the right one measures 1·6 mm. and the left which is slightly smaller than the right measures 1·5 mm.

Female.—Length about 10·00 mm. Maximum breadth in the region of vagina 0·4 mm. Pharynx and œsophagus including bulb
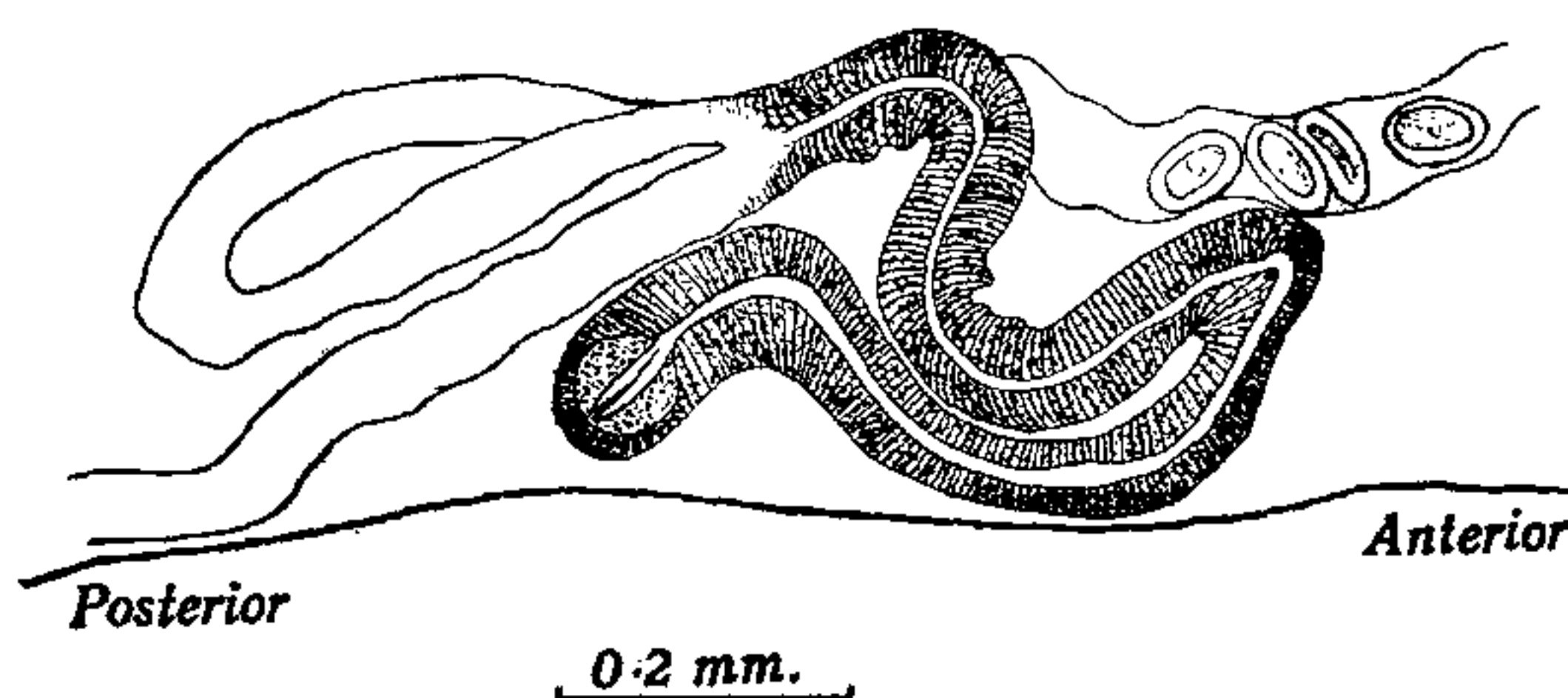

Posterior   *Anterior*

0·2 mm.

FIG. 2

Heterakis tragopanis (female), Vagina—latero-ventral view

measures 1·1 mm. of which the bulb occupies a length of 0·28 mm. Basal width of the bulb is 0·15 mm. The tail of the female is tapering into a long filament and measures 0·9 mm. The vulva which is protected by a pair of lips is situated in the pre-equatorial region of the body—4·8 mm. from the anterior end and 5·2 mm. from the posterior end. The vagina which is thickly muscular and capable of great expansion is 1·3 mm. long and runs cephalad from the vulva for half its length. It then bends caudad and after running for a short distance again bends cephalad but immediately

makes a sharp turn caudad where it divides into two uterine tubes. One of these after running caudad beyond the anal opening bends cephalad and runs anteriorly, the other shortly after divergence turns on itself and runs cephalad dorsal to the vagina. The eggs are oval and thick-shelled. They measure 0·075 mm. × 0·04 mm. in cross axes.

Discussion.—A large number of species[2] of the genus *Heterakis* have been described from different hosts in various parts of the world. The distinction between these species has been based apparently upon the number and arrangement of caudal papillæ, nature and size of spicules, size and position of pre-cloacal sucker, position of vulvar opening and size of eggs. Maplestone (1932)[3] is of opinion that none of these characters except the shape and, within wide limits, the size of spicules are constant enough to discriminate between the various species. He thinks that the other characters mentioned above are subject to very great variation and hence are not reliable for taxonomic purpose. He lays special emphasis on the shape of the tip of the shorter spicule. To me, however, this character appears to be extremely variable. Even Maplestone does not seem to be very clear on this point as in his own paper referred to here the following two statements need comment:—

On page 416, Maplestone says, "The only male characters which appear to be reliable for specific distinction are shape and within wide limits, the size of the spicules. This applies specially to the shorter spicule in all the species studied, for in practically every instance the tip has a characteristic barb or curve which only *varies slightly* within the species."

On page 405, Maplestone says, "Lane (1917)[4] in his description of the worm, under the name *H. vesicularis*, drew attention to the characteristic double curve at the end of the short spicule. This curve is only visible when the spicule is seen from the side, and I have found the degree and abruptness of the curve to *vary considerably* in different individuals."

The second objection in accepting Maplestone's view is the apparent difficulty in distinguishing between *H. gallinœ* and *H. variabilis*,[5] both of which are valid species according to Maplestone. In both cases the shorter spicule shows a more or less double curve at the tip and the size of the spicules in the two species also is more or less covered up uniformly by the measurements given. It may, therefore, be more desirable to consider all the characters together and not the character of spicule alone in distinguishing between the various species of the genus.

In view of these observations it may be said that the present form differs widely from most of the hitherto known species but comes nearest to *H. gallinœ*, *H. bosia* and *H. isolonche*. From all these species, however, it differs in the number, shape and arrangement of the caudal papillæ, relative sizes of the spicules, the size of the pre-cloacal sucker, and the course of vagina. It differs further from *H. gallinœ* and *H. bosia* in having a pre-equatorial vulvar opening and from *H. isolonche* in the position of the pre-cloacal sucker. It is, therefore, described as a new species.

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[2] See Cram E. B., " Bird parasites of the Nematode suborders Strongylata, Ascaridata and Spirurata," *Bull. U.S. Nat. Mus.*, 1927, 110.

[3] Maplestone, P. A., " The genera *Heterakis* and *Pseudaspidodera* in Indian hosts," *Ind. Journ. Med. Res.*, 1932, 20.

[4] Lane C., " Suckered roundworms from India and Ceylon " *Ibid.*, 1914, 2.

[5] Baylis, H. A., has since mentioned *H. variabilis* as a synonym of *H. isolonche*. (Vide *The Fauna of British India, Nematoda*, 1936, 1.)

LETTERS TO THE EDITOR

THE EQUATIONS OF FIT IN GENERAL RELATIVITY

FOR an isolated mass of fluid having the boundary

$$f(x^\mu) = 0 \tag{1}$$

the internal field is given by $g_{\mu\nu}$ satisfying the equations,

$$G_{\mu\nu} - \tfrac{1}{2} G g_{\mu\nu} = -KT_{\mu\nu} \equiv$$
$$-k(p+\rho)v_\mu v_\nu + kp g_{\mu\nu}, \tag{2}$$

and the external field by $g'_{\mu\nu}$ which are subject to

$$G_{\mu\nu} = 0. \tag{3}$$

The equations of fit are usually stated as

$$g_{\mu\nu} = g'_{\mu\nu}, \quad p = 0. \tag{4}$$

These boundary conditions are not usually sufficient. Consider, as an example, the external field,

$$ds^2 = -(1+m/2r)^4 (dr^2 + r^2 d\theta^2 + r^2 \sin^2\theta d\phi^2)$$
$$+ \left(\frac{1-m/2r}{1+m/2r}\right)^2 dt^2 \tag{5}$$

for $r \geqslant a$ and the internal field, for $r \leqslant a$,

$$ds^2 = -e^\mu (dr^2 + r^2 d\theta^2 + r^2 \sin^2\theta d\phi^2) + e^\nu dt^2, \tag{6}$$

μ and ν are functions of r and when the differential equations for them are solved four arbitrary constants appear in them. The equations of fit (4) provide only three conditions. We find now that there is a fourth condition, viz.,

$$\left[e^{\mu/2} r^2 \frac{\partial}{\partial r}(e^{\nu/2})\right]_{r=a} = m, \tag{7}$$

which has got to be satisfied if the distribution given by (6) is to behave like a particle of mass m at great distances. Using (4) and (7) we get

$$e^\mu = \frac{(1+m/2a)^6}{(1+mr^2/2a^3)^2},$$

$$e^\nu = \left(\frac{2-m/2a}{1+m/2a} - \frac{1}{1+mr^2/2a^3}\right)^2, \tag{8}$$

$$8\pi\rho = \frac{6m/a^3}{(1+m/2a)^6},$$

$$8\pi p = \frac{(3m^2/a^4)(1-r^2/a^2)}{(1+m/2a)^6(1-m/a+mr^2/a^3-m^2r^2/4a^4)}. \tag{9}$$

G. K. Patwardhan and P. C. Vaidya have shown in a paper, which is awaiting publication, how (7) arises from the principles of conservation. It is implicit in Tolman's[2] exposition