

**NEMATODE PARASITES OF OCEANICA. XII. A REVIEW OF
HETERAKIS SPECIES, PARTICULARLY FROM BIRDS OF
TAIWAN AND PALAWAN**

By

W. GRANT INGLIS, THE SOUTH AUSTRALIAN MUSEUM, ADELAIDE, SOUTH
AUSTRALIA

GERALD D. SCHMIDT, DEPARTMENT OF BIOLOGY, UNIVERSITY OF
NORTHERN COLORADO, GREELEY, COLORADO 80631, AND NATO
FELLOW, SOUTH AUSTRALIAN MUSEUM

and

ROBERT E. KUNTZ, DEPARTMENT OF PARASITOLOGY, SOUTHWEST
FOUNDATION FOR RESEARCH AND EDUCATION, SAN ANTONIO,
TEXAS AND U.S. NAVY MEDICAL RESEARCH UNIT No. 2, TAIPEI,
TAIWAN, REPUBLIC OF CHINA

ABSTRACT

The following species of *Heterakis* are recorded from Taiwan and Palawan: *H. variabilis* Chandler, 1926, from *Lophura swinhoii*, *Bambusicola thoracica*, and *Syrnaticus mikado*, Taiwan; *H. vulvolabiata* Chandler, 1926, from *Arborophila crudigularis*, Taiwan; *H. isolonche* Linstow, 1906, from *Lophura swinhoii*, Taiwan; *H. beramporia* Lane, 1914, from *Gallus gallus*, Taiwan; *H. spumosa* Schneider, 1866, from (?) *Rallina eurizonoides*, Taiwan; and *H. indica* Maplestone, 1932, from *Surniculus lugubris minimus*, Palawan; *H. vexans* sp. nov. is described and *H. variabilis* and *H. vulvolabiata* are redescribed.

INTRODUCTION

The limits of the superfamily Heterakoidea are fairly well established. The genera, with minor exceptions, are reasonably stable while even the families and subfamilies are recognizably the same groups in the various treatments of the superfamily. A major area of disagreement, however, continues to be the division of the genus *Heterakis* s.l. into two genera on the equality or otherwise of the spicules.

López-Néyra (1947) first used equality and inequality of the spicules as a way of delimiting groups which he called *Heterakis* and *Ganguleterakis* and has been followed in this by Skrjabin and his co-workers in several publications (most recently Skrjabin, Schikhobalova, and Lagodovskaja, 1961). Because of criticism of the artificiality of this simple criterion,

Freitas (1956) attempted to refine the distinction by defining unequal spicules as those in which the difference in length of the spicules is at least one third the length of the shorter and on this basis introduced a new name, *Raillietakis*, for species with "equal" spicules, an argument accepted by Yamaguti (1961). Madsen (1950), Inglis (1958, 1967) and Chabaud (1965) do not consider inequality of spicule length sufficient for the delimitation of genera, even as refined by Freitas, although all recognize that the structure and relative lengths of the spicules can be valuable in delimiting species.

The disagreement is partly because of the uniformity of the structures of the male tail in *Heterakis*, which supply almost all the characters useful in delimiting species, and partly, we suspect, because of a feeling that the genus is too diverse to be left as one taxon. However the inequality of spicule length is so obviously a bibliographic character that its value must be considered dubious. However, those who, like us, oppose its use have not established their case in detail, and the opportunity to do so has now arisen following the study of specimens of *Heterakis*, particularly from birds in Taiwan and Palawan, as well as specimens, particularly type material, from other hosts from other localities.

The former specimens were collected by R.E.K. and his associates of NAMRU—No. 2 during investigations of the parasite faunas of Taiwan and Palawan. The specimens were fixed in hot 70 per cent alcohol, stored in alcohol and glycerine, and cleared in glycerine or lactophenol.

MORPHOLOGICAL GROUPS

The posterior ends of male *Heterakis* are very similar, with an obvious circular pre-cloacal sucker on the mid-ventral surface of the male body anterior to the cloacal opening. The sucker has a distinct cuticular rim, with a papilliform sense-organ on the posterior margin. There are broad caudal alae supported by two pairs (sometimes three) of long pedunculate papillae lateral to the sucker (parasuctorials), four pairs of such papillae lateral to the cloacal opening (paracloacals) and one pair roughly half-way between the cloacal opening and the tip of the tail (postcloacals). In addition there are two pairs of sessile papillae around the cloacal opening (pericloacals) and a group of two pairs at the posterior end of the tail, with the phasmids immediately anterior to them. Variation in these papillae is usually restricted to a reduction in the number of para-cloacals or to the presence of an additional pair of pedunculate papillae between the para- and postcloacal papillae.

Attempts have been made to delimit species on the basis of the distribution of these papillae and on the presence or absence of an additional pair, but in most cases this has later been shown to be unsound.

In contrast, the structure of the spicules supplies the most obvious characters which delimit species and there has never been any doubt about its value. Similarly, there is no doubt that groups of species exist in which the spicules are either equal or unequal; the disagreement is about the value of separating such groups and the way in which the groups should be diagnosed. The major argument about such groupings, other than simple belief statements, is that other groups can be recognized on other features of the spicules, as was pointed out very briefly by Inglis (1967). This is now considered in detail and three major groups can be recognized.

Heterakis dispar—Group

This group consists of the nominal species *H. altaica* Spaul, 1929; *H. brevispiculum* Gendre, 1911; *H. caudata* Linstow, 1906; *H. circumvallata* Linstow, 1906; *H. dispar* (Schränk, 1790) Dujardin, 1845; *H. hyperborea* Swinyard, 1931; *H. papillosa* (Bloch, 1782) Cram, 1927; *H. silindae* Sand-ground, 1933; *H. skarbilowitschii* Kassimov, 1946; *H. stylosa* Linstow, 1907; *H. tenuicauda* Linstow, 1883; *H. travassosi* Khalil, 1932.

In all these nominal species the spicules are nonalate, equal in length and identical in structure with spiral flanges on their posterior ends (Figs. 1-3; 5-7). These spiral flanges, which are difficult to see at low magnification, have been overlooked in some descriptions and have been described as hooks or barbs in others. In all cases, however, they are cuticular expansions of the spicules which spiral round the tip.

Within this group of twelve names there appear to be only three actual species: one characterized by a large goblet-shaped pre-cloacal sucker which lies relatively close to the cloacal opening, and by a relatively long tail; a second characterized by a similar sucker lying relatively far anterior to the cloacal opening, and by a short tail so that the para-cloacal papillae appear bunched together; and a third characterized by a long, narrow tail, relatively long spicules and by a small pre-cloacal sucker which lies low on the surface of the body.

The earliest names for these species are *H. altaica*, *H. brevispiculum* and *H. papillosa* respectively with the synonyms listed below. However the problem is by no means resolved and it is possible that more species can be recognized or even that there is only one, particularly as "*altaica*" is somewhat intermediate in form between the other two.

Provisional synonymies are (the name of an institution in parentheses indicates that type specimens are lodged there and have been studied):

Heterakis altaica Spaul, 1929, (British Museum (Nat. Hist.))
Synonymy: *H. skarbilowitschii* Kassimov, 1946.

Spaul overlooked the spicular flanges, which are well figured by Kassimow: it is possible that *H. macroura* Linstow, 1883, is this species. Freitas (1956) refers *H. altaica* to *Odontoterakis* but this is completely wrong.

***Heterakis brevispiculum* Gendre, 1911**

Synonymy: *H. travassosi* Khalil, 1932 (Tropeninstitut, Hamburg). *H. silindae* Sandground, 1933 (Museum of Comparative Zoology, Harvard).

***Heterakis dispar* (Schrank, 1790) (Naturhistorisches Museum, Vienna)**

Synonymy: ?*Ascaris papillosa* Bloch, 1782, *H. caudata* Linstow, 1906; *H. circumvallata* Linstow, 1906; *H. hyperborea* Swinyard, 1931; (?) *H. monticelliana* Stossich, 1892; *H. stylosa* Linstow, 1907 (Instit. für Spez. Zoo., Berlin); *H. tenuicauda* Linstow, 1883 (Brit. Mus. (Nat. Hist.)).

In the most recent redescription of *H. papillosa* to be published, Madsen (1950) failed to see the spiral flanges on the posterior ends of the spicules. However one of us (W.G.I.) has examined Madsen's material, as well as specimens from the type host (*Otis tarda*) in captivity and in the wild, and flanges are present on the spicules of all males studied. As there are no other obvious differences between the two nominal species *H. dispar* is almost certainly indistinguishable from *H. papillosa*. However, *H. dispar* is a name very widely used, particularly in veterinary literature and it is preferable that it remains unchanged. Further, the problem of delimiting the species of this group is not fully resolved. We therefore prefer to retain *H. dispar* and to treat *H. papillosa* only as a probable synonym.

In addition to these species we later describe a fourth, *H. vexans* sp. nov., which is most appropriately accommodated within this *H. dispar*-group, although the flanges on the posterior ends of the identical spicules are non-spiral.

***Heterakis gallinarum*—Group**

This group contains *H. beramporia* Lane, 1914; *H. bonasae* Cram, 1927; *H. bosia* Lane, 1914; *H. caudebrevis* Popova, 1949; *H. gallinarum* (Schrank, 1788) Madsen, 1949 (—*H. pediocytes* Mawson, 1956 (Institute of Parasitology, McDonald College)); *H. indica* Maplestone, 1932; *H. isolonche* Linstow, 1906; *H. pavonis* Maplestone, 1932 (= *H. yamadori* Yamaguti, 1941); *H. putaustralis* Lane, 1914; *H. variabilis* Chandler, 1926; *H. vulvolabiata* Chandler, 1926.

In all these species the left spicule at least, and in some both, is alate or obviously different from the right. The most diagnostic character of the various species is the shape of the left spicule, of which the tip can be elaborate.

The major problem in this species group is the relationships between and the delimitation of those species in which the right spicule is long and slim while the left is usually short but always with broad alae and a relatively simple posterior end. These worms appear to form a cline from species with markedly unequal spicules at one extreme to species with equal spicules at the other. At one extreme is *H. gallinarum* in which the left, terminally hooked, spicule is much shorter than the right, and at the other extreme is *H. isolonche* in which the spicules are about the same length. Intermediate between the extremes are *H. variabilis* Chandler, 1926 (redescribed below), *H. putaustralis* Lane, 1914 and *H. bonasae* Cram, 1927. Basically similar to *H. gallinarum* in having a short, left spicule are *H. pavonis* Maplestone, 1932 and *H. indica* Maplestone, 1932, but in both species the left spicule has an elaborate tip.

This problem still awaits resolution but is the major reason we do not accept a split of the genus *Heterakis* on the basis of the relative lengths of the spicules. The remaining species listed are less happily included in this group and might warrant treatment as a fourth species-group. Nevertheless we leave them here at present as a matter of convenience.

***Heterakis alata*—Group**

This group contains *H. bancrofti* Johnston, 1912; *H. alata* Schneider 1866 (= *H. arquata* Schneider, 1866 = *H. skrjabini* Cram 1927); *H. brasiliensis* Linstow, 1899 (Institut. für Spez. Zoo., Berlin); *H. nattereri* Travassos, 1913.

In all the species of this group the spicules are without alae and, in most species, are slim. In none is there an elaboration of the tip of the left spicule and all occur in hosts in South America, except *H. bancrofti* which was found in an Australian host.

REMAINING SPECIES

Among the remaining species usually referred to *Heterakis*, *H. spumosa* Schneider, 1886, is probably the most widespread and best known. It is the only species of *Heterakis* which occurs in mammals and is widespread in rats throughout the World. It is characterised by equal and identical needle-like spicules, three pairs of para-cloacal papillae and no "post cloacal" pair or, another interpretation, has only two pairs of para-cloacal papillae of which the more anterior pair is very large and may represent three fused papillae. Because of these differences Lane (1914) described this species as *Ganguleterakis gangula*, having over-looked Schneider's earlier description. Since then the generic name *Ganguleterakis* has been used by some authors for a group containing so-called "equal spicule" species of *Heterakis*. This,

as argued above, we do not accept but recognize that *H. spumosa* is very different from the typical *Heterakis* of birds and the recognition of a genus for it alone could be accepted if one so desired.

H. macrospiculum Ortlepp, 1939, *H. spalacis* Marçu, 1930 and *Ganguleterakis spalaxi* Kozlov and Yangolenko, 1967, do not appear to be species of *Heterakis*. It is possible that *H. macrospiculum* is an *Africana* species and that the other two, which are probably indistinguishable, are *Ascaridia*.

HOST AND GEOGRAPHICAL DISTRIBUTIONS

Species of the genus *Heterakis* occur widely in the caecum of ground-feeding, grain-eating birds throughout the world, with some species in water fowl and a few other hosts. The members of the *H. alata*-group are restricted to birds in South America while the other two groups occur in birds in the rest of the world. The sole exception is *H. bancrofti* Johnston, 1912, which occurs in Australia but is morphologically a member of the South American *alata*-group. Such a geographical relationship is interesting in reinforcing other Australian-Neotropical faunal relationships and so does not destroy the primarily South American relationships of the *alata*-group. It would, therefore, appear that the groups of species have arisen in response to geographical separation.

Support for this is given by the genus *Odontoterakis*, restricted to South America, in which the spicules are always simple, needle-like, and identical in structure. In this its members resemble the South American *H. alata*-group. The genus *Pseudospidodera*, in contrast, is restricted to India and related countries and the spicules are unequal with the right long and thin and the left short with broad alae (except in *P. jnanendrae* Chakravarty, 1938; but this species is in need of redescription), as in the *H. gallinarum*-group.

It is probable that *Odontoterakis* arose from the *Heterakis* species found in South American hosts while *Pseudaspododera* arose from the *H. gallinarum*-group of species in South Asia. To this extent the species groups recognized in *Heterakis* are supported not only by the morphological and geographical data within the genus itself but also by the similar evidence supplied by the species grouped in *Pseudaspododera* and *Odontoterakis*.

If the genus *Heterakis* is to be fragmented on the basis of spicule structure, rather than on the relative lengths of the spicules, part of it (the *gallinarum*-group) could be grouped with *Pseudaspododera* species, part of it (the *alata*-group) with *Odontoterakis* while the remaining part (the *dispar*-group) would be left as a distinct genus. Such groupings might reflect the evolution of the group more accurately than the classification of Inglis

(1967), since *Odontaterakis* and *Pseudaspidodera* probably evolved from *Heterakis* species. Nevertheless, it is more reasonable and convenient to leave the generic groupings as they stand with *Heterakis* as one cosmopolitan genus.

The relationships of the *brevispiculum*-group remain uncertain as they could have arisen from either of the other groups. No decision on this is possible at this time although the new species described below (*H. vexans*) suggests an intermediate between the *dispar*- and *alata*-groups.

DESCRIPTIVE SECTION

All measurements are in microns unless otherwise stated and all specimens have been deposited in the collections of the U.S. National Museum Helminthological Collection, Beltsville, Maryland.

***Heterakis vexans* sp. nov.**

(Figs. 8 and 14)

A single male was found among several *H. vulvolabiata* Chandler, 1926, obtained from the caecum (?) of a Formosan hill partridge, and appears to represent a new species.

DESCRIPTION

Morphology typical for genus. Lips (Fig. 8) rather small, with conspicuous papillae. Lateral alae prominent. Anterior end curved dorsad.

Male: 5.0 mm. long, 280 greatest width (1.0 mm. posterior to anterior end). Oesophagus (excluding pharynx) 665 long, with posterior bulb 112 greatest width. Pharynx (measured from flange tooth to junction with oesophagus) 48 long. Excretory pore 330 from anterior end. Nerve ring 216 from anterior end. Precloacal sucker (Fig. 14) 51 long, 48 wide (measured across outer margins of sclerotized wall), posterior edge 64 from anus. Tail 340 long. Spicules (Fig. 14) subequal, very stout, with similar tips, each with sharp, recurved hook at tip and subterminal inflation in lateral view. Spicules lacking alae, but each with narrow longitudinal flange along subterminal swelling. Right spicule 450 long, left spicule 380 long. Caudal papillae typical of genus but with only three pairs of paracloacals.

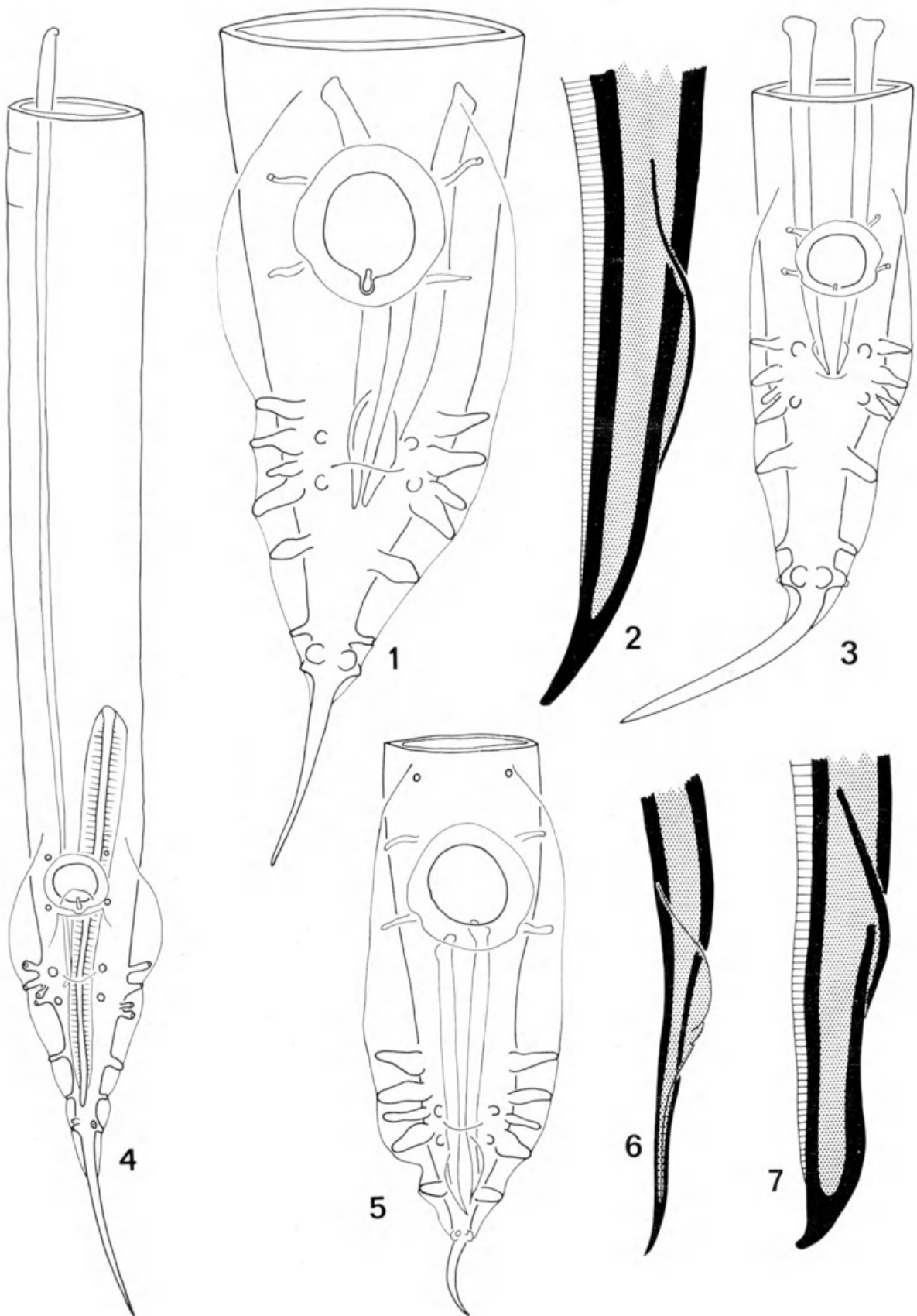
Female: Unknown.

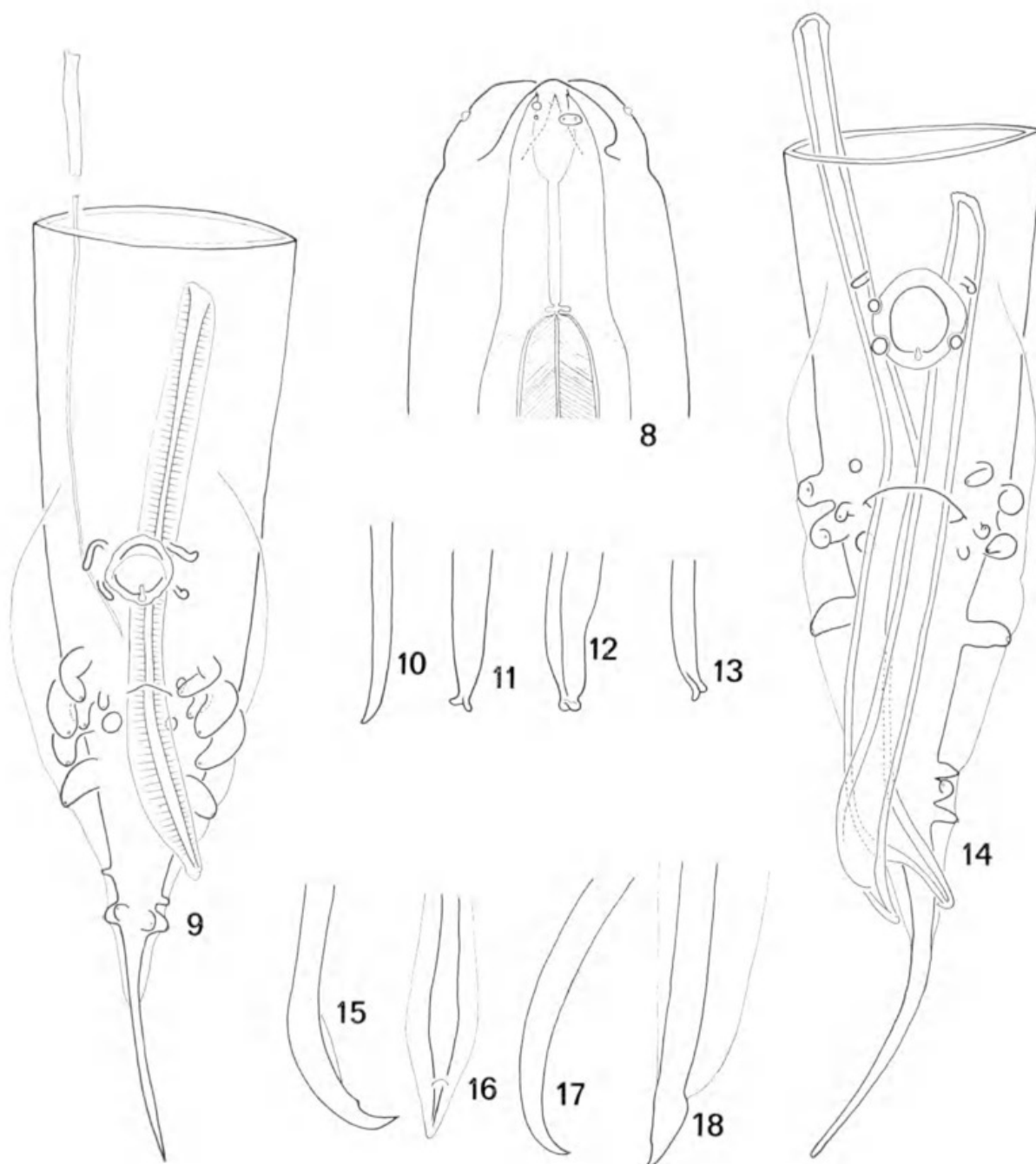
Type host: Formosan hill partridge, *Arborophila crudigularis* (Swinhoe, 1864). (Phasianidae: Galliformes.)

Location: Probably caecum.

Type locality: Sun-Moon Lake, Nan-tou Hsien, Taiwan.

Type specimen: USNM Helm. Coll. holotype male no. 63228.





Figs. 1 and 2. *H. altaica*; 3 and 7. *H. dispar*; 4. *H. variabilis*; 5 and 6. *H. brevispiculum*; 8 and 14. *H. vexans*; 9 and 13. *H. vulvolabiata*; 10. *H. alata*; 11 and 12. *H. indica*; 15 and 16. *H. beramporia*; 17 and 18. *H. isolonche*.

Remarks: In spicule length, *Heterakis vexans* sp.n. is most similar to *Heterakis parva* Maplestone, 1931, but the spicules of that species are more slender and lack the terminal flanges characteristic of the *H. brevispiculum*-group found on *H. vexans*. The shapes of the spicules are closest to *Heterakis altaica* Spaul, 1929, from Asian galliform birds. Syntypes of this latter species were studied by one of us (W.G.I.) and the spicules are not as robust as those of *H. vexans* and they also lack the terminal hooks. Neither *H. parva* nor *H. altaica* are known to have three lateral paraocloacal papillae. These papillae are variable in other species; it is common for one pair to be lost through fusion with an adjacent pair. On the other hand, *H. psophiae* Travassos, 1913, consistently has only three pairs. It will remain for subsequent discoveries of *H. vexans* to prove if this is a consistent feature of the species.

***Heterakis variabilis* Chandler, 1926**

(Fig. 4)

The following redescription is based on twenty males and nine females from three species of gallinaceous hosts. All specimens are in excellent condition.

DESCRIPTION

Morphology typical for genus. Lips large, with characteristic papillae. Additional pair of inconspicuous papillae occasionally present on each side, posterior to lips. Lateral alae prominent. Anterior end usually curved dorsad.

Male: 6.0 to 9.4 mm. long, 290 to 335 greatest width (1.0 mm. posterior to oesophagus). Oesophagus (excluding pharynx) 0.850 to 1.15 mm. long, with posterior bulb 150 to 180 greatest width. Pharynx (measured from anterior tooth to junction with oesophagus) 50 to 65 long. Excretory pore 320 to 400 from anterior end. Nerve ring 230 to 325 from anterior end. Precloacal sucker (Fig. 4) 70 to 85 long, 60 to 90 wide (measured across outer margins of sclerotized wall), posterior edge 105 to 150 from anus. Tail 410 to 670 long. Right spicule 1.20 to 1.97 mm. long, lacking alae. Left spicule 410 to 900 long, with well-developed alae. Caudal papillae typical of genus, but variable in number and location. Occasionally, a supernumerary single or pair of small, sessile papillae is present anterior to sucker.

Female: (all specimens gravid). 7.0 to 11.0 mm. long, 265 to 360 greatest width (1.0 mm. posterior to oesophagus). Oesophagus (excluding pharynx) 0.960 to 1.15 mm. long, with posterior bulb 150 to 180 greatest

width. Pharynx 65 to 80 long. Excretory pore 350 to 480 from anterior end. Nerve ring 240 to 325 from anterior end. Tail 0.912 to 1.3 mm. long. Vulva salient or not, 3.35 to 5.57 mm. from posterior end. Ovijector with distal loop. Eggs (measured in ovijector) 60 to 76 by 35 to 40. Two (rarely one or three) tandem, large, postvulvar papillae.

Hosts: Swinhoe's blue pheasant, *Lophura swinhoii* (Gould, 1863); bamboo partridge, *Bambusicola thoracica sonoricox* Gould, 1862; mikado pheasant, *Syrnaticus mikado* (Ogilvie-Grant, 1906). (Phasianidae: Galliformes.)

Location: Caecum and large intestine.

Localities: Wu-lai, Tai-peí Hsien; Pu-li and Wu-sheh, Nan-tou Hsien; Ta-fu, Hua-lien Hsien; Hsin-sheh, Tai-chung Hsien; I-lan, I-lan Hsien; Taiwan.

Specimens deposited: U.S.N.M. Helm. Coll. nos. 63221-63223.

REMARKS

Chandler (1926) described this species from specimens recovered from three peacock pheasants, *Polyplectrum bicalcaratum* (L.), which had died in the Calcutta Zoological Gardens. Maplestone (1932) recorded this species from the type host in India, and Inglis (1958) found it in the type host in the London Zoological Gardens. Baylis (1936) and Madsen (1950) consider this species to be a synonym of *Heterakis isolonche* Linstow, 1906, but that species has spicules roughly equal in length while they are markedly unequal in *H. variabilis*. Inglis (1958) suggested that *Heterakis parva* Maplestone, 1931, may be a synonym of *H. variabilis*, but the present study shows this not to be the case (see below). *Heterakis variabilis* can easily be recognized by the sizes and shapes of the spicules.

The tiny papillae behind the head have not been reported previously for this species although we have seen them repeatedly in other species. Their structure and function remain problematical. Postvulvar papillae are present on every specimen of *H. variabilis* that we have studied, including subadults where they are small and appear to be developing. They always appear in tandem, are transversely elongate, and have hypodermis intruding into them. No nervous element could be seen. It seems to us unlikely that they were formed by the sucker of the male during copulation, because of their size, shape, and location. Possibly they aid in locating the male genital pore. Similar structures are known in the hookworm genus *Arthrostoma* Cameron, 1926.

Heterakis vulvolabiata Chandler, 1926

(Figs. 9 and 13)

The following redescription is based on fifteen males and ten females from six Formosan hill partridges. All specimens are in good to excellent condition.

DESCRIPTION

A small, slender heterakid, with morphology typical for genus. Lateral alae narrow. Anterior end usually curved dorsad.

Male: 4.3 to 5.1 mm. long, 168 to 196 maximum width (1.00 mm. posterior to oesophagus). Oesophagus (excluding pharynx) 530 to 650 long, with posterior bulb 80 to 120 greatest width. Pharynx 40 to 50 long. Excretory pore 240 to 300 from anterior end. Nerve ring 200 to 235 from anterior end. Precloacal sucker (Fig. 9) 31 to 40 long, 32 to 40 wide; posterior edge 30 to 50 from anus. Tail 200 to 230 long. Right spicule 460 to 570 long, very slender, needle-like, lacking alae, with simple tip. Left spicule (Fig. 13) 290 to 335 long, stout, alate, with blunt, slightly bifid tip. Caudal papillae typical of genus, but variable in number and location. Supernumerary papillae anterior to sucker not observed.

Female: (All specimens gravid). 5.0 to 7.0 mm. long, 190 to 265 maximum width (1.0 mm. posterior to oesophagus). Oesophagus (excluding pharynx) 575 to 865 long, with posterior bulb 100 to 140 greatest width. Pharynx 40 to 64 long. Excretory pore 260 to 388 from anterior end. Nerve ring 205 to 330 from anterior end. Tail 335 to 695 long. Vulva salient or not, 2.4 to 3.4 mm. from posterior end. Post vulvar papillae absent. Ovijector with tight, distal loop. Eggs (measured in uterus) 66 to 70 by 36 to 40.

Host: Formosan hill partridge, *Arborophila crudigularis*. (Phasianidae: Galliformes).

Location: Caecum and large intestine.

Localities: Pu-li, Sun-Moon-Lake, Nan-tou Hsien; Shih-men, Ping-tung Hsien, Taiwan.

Specimens deposited: U.S.N.M. Helm. Coll. no. 63220.

REMARKS

Chandler (1926) described this species from specimens recovered from *Arborophila torqueola* (Valenc.) which had died in the Calcutta Zoological Gardens. Our specimens are somewhat smaller than those of Chandler, although the spicule sizes are similar. Chandler apparently reversed the left

and right spicules, for he stated the left was longer. Maplestone (1932) simply referred to a longer and shorter spicule, but he did figure the characteristically-tipped short spicule for the first time. Baylis (1936) described the right spicule as longer.

The present record is the first outside India, and the host record is also new. The species is readily recognized by its small size and the very characteristic delicate right spicule.

***Heterakis beramporia* Lane, 1914**

(Figs. 15 and 16)

Several specimens were found in a domestic fowl, *Gallus gallus* (L.) from Tai-pei, Tai-pei Hsien, Taiwan. This is a common parasite of fowls in Asia, but appears not to have been reported previously from Taiwan. These specimens were overlooked in a previous report (Schmidt and Kuntz, 1970).

Specimens deposited: U.S.N.M. Helm. Coll. no. 63225.

***Heterakis spumosa* Schneider, 1866**

Our data record this species from a banded crane, *Rallina eurizonoides formosana* Seebohm, 1894 (Rallidae) from Chiao-chi, I-lan Hsien, Taiwan. Since this is a cosmopolitan parasite of domestic rats and other rodents, the record seems dubious and should be viewed with suspicion. The occurrence of this parasite on Taiwan should be noted, however.

Specimens deposited: U.S.N.M. Helm. Coll. no. 63226.

***Heterakis indica* Maplestone, 1932**

(Figs. 11 and 12)

Two males, one incomplete, were found in a drongo cuckoo, *Surniculus lugubris minimus* Baker (Cuculidae), at Terabanan Concepcion, Palawan, Republic of the Philippines. This is a new host record, although it has been reported from domestic fowls from Palawan by Schmidt and Kuntz (1970). The species was adequately described by Maplestone (1932) and by Li (1933) (as *H. lingnamensis*). Inglis (1958) hesitated to recognize this species, since specimens were not available for study. The present study fully supports the status of the species.

Specimens deposited: U.S.N.M. Helm. Coll. no. 63227.

Heterakis isolonche Linstow, 1906

(Figs. 17 and 18)

(Syn. *H. putaustralis* Maplestone, 1922; *H. tragopanis* Lal, 1942.)

Several specimens were found in the caecum and large intestine of a Swinhoe's blue pheasant, *Lophura swinhoii*, from Chun-yeh, Ping-tung Hsien, Taiwan. These are new host and locality records. This well-known parasite has been recorded from a wide range of galliform birds in Asia, Europe and North America and was adequately redescribed by Li (1933).

Specimens deposited: U.S.N.M. Helm. Coll. no. 63224.

ACKNOWLEDGEMENTS

The authors wish to acknowledge the field support by Dr. D. S. Rabor, Department of Biology, Silliman University, Dumaguete City, Negros Oriental, Republic of the Philippines, and the technicians of the Parasitology Department of Naval Medical Research Unit No. 2 for general assistance in obtaining and examining hosts. Dr. B. J. Myers aided in preliminary processing of specimens.

Initial work for this study was supported by funding under Public Law 480, Section 104 (c), by funds provided by the United States Bureau of Medicine and Surgery, Navy Department Work Unit MR 005.20-0098, and by Contract No. NR 103-690/N0014-66-C0094, between the United States office of Naval Research, Department of the Navy, and the Southwest Foundation for Research and Education.

Final efforts were sponsored by United States Department of the Army, Contract No. DADA 17-68-C-8094.

Work in South Australia was completed while one of us (G.D.S.) was a visiting NATO Fellow and was supported by funds to W.G.I. from the Mark Mitchell Foundation and the Australian Grants Committee.

REFERENCES

- Baylis, H. A., 1936: *The fauna of British India. Nematoda I.* (Ascaridoidea and Strongyloidea). Taylor and Francis. London.
- Chabaud, A. G., 1965: Superfamille des Heterakoidea, in *Traité de Zoologie* 4 (3): 1010-1016.
- Chandler, A. C., 1926: New Heterakidae from Indian galliform birds. *Indian J. med. Res.* 13: 617-623.
- Freitas, J. F., Teixeira de, 1956: Notas sobre "Heterakidae". Railliet and Henry, 1914. (Nematoda, Subuluroidea). *Rev. bras. Biol.* 16: 461-482.
- Inglis, W. G., 1958: A review of the nematode superfamily Heterakoidea. *Ann. Mag. nat. Hist.* (12) 10: 905-912. (N.B. This paper is misdated 1957 as printed but was published 4th June, 1958.)
- Inglis, W. G., 1967: The evolution, host relationships and classification of the nematode superfamily Heterakoidea. *Bull. Brit. Mus. nat. Hist. (Zoology)* 15 (1): 1-28.
- Li, H. C., 1933: Parasitic nematodes mainly from North China. Part IV. Oxyuroidea. *Chinese Med. J.* 47: 1307-1325.
- López-Néyra, C. R., 1947: *Helminths de los vertebrados Ibéricos II*. Granada.
- Madsen, H., 1950: Studies on species of *Heterakis* (Nematoda) in birds. *Danish Rev. Game Biol.* 1: 1-42.
- Maplestone, P. A., 1932: The genera *Heterakis* and *Pseudaspidodera* in Indian hosts. *Rec. Indian Mus.* 20: 403-420.
- Schmidt, G. D. and R. E. Kuntz, 1970: Nematode parasites of Oceanica VII. New records from wild and domestic chickens (*Gallus gallus*) from Palawan (Philippine Islands), Sabah (Malaysia), and Taiwan. *Avian Diseases* 14: 184-187.



Inglis, W Grant, Schmidt, Gerald D., and Kuntz, R E. 1971. "NEMATODE PARASITES OF OCEANICA PART 12 A REVIEW OF HETERAKIS SPECIES PARTICULARLY FROM BIRDS OF TAIWAN AND PALAWAN." *Records of the South Australian Museum* 16, 1–14.

View This Item Online: <https://www.biodiversitylibrary.org/item/127009>

Permalink: <https://www.biodiversitylibrary.org/partpdf/78725>

Holding Institution

South Australian Museum

Sponsored by

Atlas of Living Australia

Copyright & Reuse

Copyright Status: In copyright. Digitized with the permission of the rights holder.

License: <http://creativecommons.org/licenses/by-nc-sa/3.0/>

Rights: <https://biodiversitylibrary.org/permissions>

This document was created from content at the **Biodiversity Heritage Library**, the world's largest open access digital library for biodiversity literature and archives. Visit BHL at <https://www.biodiversitylibrary.org>.