THE APPLICATION OF THE POLYTOMOUS PRINCIPLES TO THE IDENTIFICATION TO NEMATODES OF THE GENUS *XIPHINEMA* COBB[1]

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Nematodes play a very diverse and important role in nature. Some of them have adapted to act as parasites of animals and man. Free-living saprobiotic species play an active part in the decomposition of organic matter in the soil, assisting in the process of humus formation.

Many species of phytohelminths are connected to a greater or lesser degree with different plants: some of them are important pests of valuable agricultural crops. Damage caused by these nematodes amounts to hundreds of millions of rubles annually (C.L. Duddington, 1957).

Due to their small body dimensions (usually less than one millimeter) these worms, according to V.K. Eglitis (1954) and F. Schaller (1962) can number hundreds of billions in one year, to produce a live mass of 50 kg per hectare.

Nematodes from the group of phytohelminths with a specific pathogenic effect cause characteristic changes in plant organs and tissues, by which means the genus or species affecting the plant can be exactly determined.

However, the presence of many species of phytohelminths of a non-specific pathogenic effect, that cause no less serious damage to crops, can prevent the establishment of any typical external characteristics of infection. In such cases it is especially important to determine the nematode species, since related species or morphologically similar forms frequently can play very different roles in the biology of the plant upon which they feed.

Well-known among nematodes of the genus *Xiphinema* are some important pests of strawberries, roses, fruits, grapes and other crops. Moreover, two to three species of *Xiphinema* usually are present in one area. For example, in the soil of the Californian vineyards two species are found --*X. index* and *X. americanum*, but only the former demonstrates a capacity for transferring infectious degenerative vine virus. It has been established that the presence of this nematode in the soil is usually linked with the findings in a given area of grapevine "court-noué" (Dias, 1962).

Taxonomy and identification of free-living and phytoparasitic nematodes, with regard to both large and small taxonomic specimens, are in a state of constant change. More or less complete identification keys of all well-known

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[1] The identification table is formed from the systematic characteristics of the females of valid species: species inquirendae (Luc & Tarjan, 1963) are not included in this identification.

species have become obsolete but there are only a few new keys and these far from consider all species and genera that almost daily come under the heading 'new to science'. All available identification keys of nematodes are constructed according to the dichotomous principle.

One of the problems delaying the formation of new identification keys of nematodes is the diversity of species in this class of invertebrates. All descriptions of new taxonomic specimens necessitate the dismantling and reconstruction of all identification systems, that is very labor intensive and inconvenient. On the other hand, if reconstruction is neglected, then after a mere three to four years tens of new, often harmful, species remain outside the systems, thereby seriously complicating research.

The application of the polytomous principle of diagnostic in the taxonomy of free-living and phytoparasitic nematodes, would, in our opinion, considerably simplify the identification of these animals. Successful identification by this principle does not depend on the need to unite different characteristics for a thesis or antithesis, as is inevitable with identification by the dichotomous principle; the possibility of mistakes is eliminated, since identification can begin with any characteristic in any order and, finally, with the description of new taxons there is not the necessity to dismantle the whole system of identification but rather to add new identifying characteristics (B.E. Balkovsky, 1960; P.Ch. Kiskin, 1961; 1964).

To provide an example of an identification key by the polytomous principle we considered 35 species of nematode from the genus *Xiphinema* Cobb, 1913, well-known in world literature[2]. Six other species of *Xiphinema* were not included because of our lack of full details about these nematodes.

In Table A is found the description and codification of the species characteristics being used for identification; in Table B is a list with a numerical symbol for the groups of characteristics (Roman numerals) and for the characteristics themselves (Arabic).

Let us consider as an example an unidentified species belonging to the genus *Xiphinema*. For the characteristics of interest to us we check the nematodes in turn with Table A (by groups of characteristics). In the unidentified species there are two ovaries, the posterior one fully developed, but the anterior ovary noticeably reduced (approximately 3 times shorter than the posterior). Consequently, we record a number 2 for the first group of characteristics (I). Further study reveals that the tail is short (less than two anal body diameters), conical with finger-shaped terminus, which corresponds to number 4 in the second group of characteristics (II); organ 'z' in the sexual system is absent (III=2). The location of the vulva (V) in the nematode is 27.9% (IV=1); length of body L (a) = 3.2 mm (V=2); average length of stylet (including odontophore) = 138 μm (VI=). The labial area is separated from the body by a slight constriction (VII=3). Index a = 80 (VIII=3). The number of

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[2] Publications used for the formation of the identification key are marked by an asterisk in the bibliography.

caudal pores is 2 (IX=1). We extract all the numbers obtained for the groups of characteristics which gives the following result:

I	II	III	IV	V	VI	VII	VIII	IX
_	__	___	__	_	__	___	____	__
2	4	2	1	2	3	1	3	1

Checking this group of numbers in a fixed sequence against those set out in Table B, we find that it corresponds with one species of *Xiphinema*; namely, *X. orbum*.

There is also another way of identifying a specimen that is of interest to us: by specific characteristics, set out in Table B[3]. Let us begin with the first species in the table --*X. radicicola*. A distinguishing feature of this nematode is the presence in the female's sexual system of only one ovary --the posterior one (I=1), whereas, in the nematode we identified there are two of them; there is an anterior ovary, although reduced (I=2). Consequently, the specimen that interests us does not belong to the species *X. radicicola*, but to some other. The second on the list --*X. insigne*-- is characterized by the presence of two ovaries, one of which is reduced, long conical tail (more than 4 anal body diameters) and length of stylet 137-161 μm. Such a combination of characteristics (I=2, II=2, VI=1,2) does not conform with the species being examined by us, that also has two ovaries (I=2) and a short stylet (VI=1), but the tail, although conical, is short (less than 4 anal body diameters) and with finger-shaped terminus.

Thus, checking the distinguishing features of our specimen against the species in Table B, we reach the 5th in the list --*X. orbum*, which features all characteristics: 1/2 + II/4, i.e., the presence of two ovaries, of which one is reduced, short conical tail (less than 4 anal body diameters) with finger-shaped terminus and short or average length stylet that conforms to the features of the nematode being examined by us. For verification of a correct identification we can check against all the remaining characteristics --the additional ones--with the data from our nematode. If there is no divergence (but with careful identification there is no need), the specimen that interests us is identified as the species *X. orbum*.

For identification of nematodes using the polytomous principle and especially where a large number of species is included, it would be useful to utilize, either along with the numerical tables or independently, the punched card diagnostic method that is increasingly finding wider applications in very diverse areas of science and life (P.Ch. Kiskin, 1961; 1964).

Our attempt at constructing an identification key requires additional work, with the addition of illustrations and description of species, also the inclusion of the missing species of *Xiphinema* and those being newly described.

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[3] Contained in squares or underlined (for principal combinations of specific characteristics).

Table A

Description and codification of features of nematodes of the genus *Xiphinema*

Group I : Number of ovaries	
- one (posterior):	[1]
- two (one appreciable reduced, often not functioning)	2
- two (both roughly of similar maturity)	3
Group II : Tail (length and shape)	
- long (more than 4 anal diameters), whip-shaped	[1]
- long (more than 4 anal diameters), conical	2
- short (less than 4 anal diameters), conical	3
- short (less than 4 anal diameters), conical with finger-shaped end	4
- short (less than 4 anal diameters), rounded or semi-spherical	5
- short (less than 2 anal diameters), semi-spherical with short or scarcely noticeable finger-shaped end	6
- short (less than 4 anal diameters), rounded with finger-shaped end	7
Group III : Organ 'z' (presence)	
- present	1
- absent	2
Group IV : Vulva position, ratio 'V'	
- less than 30%	1
- 30-40%	2
- 40-50%	3
- more than 50%	4
Group V : Length of body (L)	
- up to 3 mm	1
- 3-4 mm	2
- more than 4 mm	3
Group VI : Length of stylet (average, including odontophore)	
- shorter than 150 μm	1
- 150-200 μm	2
- more than 200 μm	3
Group VII : Labial area	
- button-shaped	1
- separated from body by a distinct constriction	2
- separated from body by a slight constriction	3
Group VIII : Index 'a' (Relationship between length and width of body)	
- up to 40	1
- 40-60	2
- more than 60	3
Group IX : Number of caudal papillae	
- 2	1
- 3-4	2
- more than 4	3

Table B

Numerical Table For The Diagnostics of Nematodes
in the genus *Xiphinema* Cobb, 1913

Number	Species in the genus *Xiphinema*	Groups of characteristics								
		I	II	III	IV	V	VI	VII	VIII	IX
1	radicicola	1	4	2	1	1	2	1	3	2
2	insigne	2	2	2	1,2	1	1,2	3	2	3
3	longicaudatum	2	2	2	2	1	3	4	2	1
4	krugi	2	3	2	2	1	2	4	1,2	2
5	orbum	2	4	2	1	2	1,2	3	3	1
6	ensiculiferum	2	5	2	2	1	3	4	1	2
7	flagellicaudatum	3	1	2	3	1	2	1	2	1
8	hallei	3	2	2	3	2	2,3	2	3	2,3
9	nigeriense	3	2	2	3,4	1	2	3	2	2
10	vanderlindei	3	2	2	3,4	2	1	1	3	2
11	zulu	3	2,3	2	3,4	1,2	2	4	2,3	1
12	attorodorum	3	3	2	3	1	2	2	2,3	2
13	arenarium	3	3	2	3	1,2	2	1	3	2
14	opisthohysterum	3	3	2	4	1	1	1	2,3	1
15	americanum	3	3	2	4	1	1	3	1,2,3	1
16	longidoroides	3	3	2	4	1,2	2,3	3	2,3	2
17	elongatum	3	3,4	2	2	1	2	3	2	2,3
18	ebriense	3	4	1	3	1	2	3	1,2	1
19	ifacolum	3	4	1	3,4	2	2	3	2,3	2
20	bakeri	3	4	2	1,2	2,3	3	2	2,3	1
21	setariae	3	4	2	2	1	2	2	2	1
22	basiri	3	4	2	3,4	1,2	2	3	2,3	2
23	arcum	3	5	1	2	1	2	3	2	1
24	pini	3	5	1	2,3	2	2	4	2,3	2
25	turcicum	3	5	1	3	2,3	3	3	3	1
26	rotundatum	3	5	1	3,4	1,2	2,3	3	2	2
27	yapoense	3	5	2	3	2	3	2	2	1
28	clavatum	3	5	2	3,4	2	2,3	4	2,3	2
29	imitator	3	5,6	1	3,4	1	2	4	2,3	1,2
30	vuittenezi	3	5,6	2	3	2	2,3	2	2,3	2
31	ingens	3	5,6	2	3,4	3	3	3	3	1
32	mammillatum	3	6	2	2,3	1	2,3	3	2	1
33	index	3	7	2	2,3	2	2	4	2	2
34	basilgoodeyi	3	7	2	3	1,2	2,3	3	2	1
35	diversicaudatum	3	7	2	3	2,3	2,3	3	3	3

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