

Relationships of Species of *Helicotylenchus* with Taxonomic Groupings of Host Plants

Review article

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Abstract

Spiral nematode, *Helicotylenchus* (Tylenchida : Hoplolaimidae), mostly act as ectoparasite on diverse group of plants. Studies on 33 species of spiral nematodes revealed that 7 species were host specific in monocotyledons, 6 in dicotyledons-lignosae and 5 in dicotyledons-herbaceae, and were designated as monophagous. *H. digonicus*, *H. dihystra*, *H. microlobus* *H. multincinctus* and *H. psedorobustus* parasitize large number of host species and were classified as polyphagous. Host affinity to taxonomic groups was species specific. Nevertheless, a general preference was more towards dicotyledons. Some species were able to parasitize host species from most primitive families to advanced ones and some included gymnosperms also in their host range. This study will help in selecting crops in particular nich or endemic areas and contribute in decision making process for their management.

Keywords: *Helicotylenchus*; Spiral nematode; Host Range; Dicotyledons; Monocotyledons; Lignosae; Herbaceae; Calyciferae; Corolliferae; Glumiflorae; Angiosperms; Gymnosperms

Introduction

Species of *Helicotylenchus* (Tylenchida: Hoplolaimidae) are generally known as spiral nematodes because of their coiled habit [1]. They are globally distributed and associated with root systems of diverse groups of plants [2]. Most are ectoparasite and feed on root epidermis while others live half buried in the root tissues, and other penetrate root and live inside [3]. Information on damage potential is not available for many species to implicate them as serious pests, however, certain species are cosmopolitan and adversely affect the plant growth and cause considerable reduction in yield. Thorsteinson hypothesized that host selection in insects is associated with certain taxonomic groups of plants [4]. Rathore and Lal observed that host range of pod borer, *Maruca vitrata*, is strictly restricted to plants belonging to leguminous group [5]. Further, Rathore and Tiwari reported that whitefly, *Bemisia tabaci*, preferred certain group of plants and in some cases evolutionary lineage were seen [6]. Recent

studies of Rathore and Ali and Rathore and Tiwari clearly revealed such taxonomic associations in *Meloidogyne incognita* and 63 species of *Heterodera*, respectively [7,8]. In the present review an attempt has been made to analyze the relationship of *Helicotylenchus* with its host spectrum.

The review encompasses thirty-three species of *Helicotylenchus* the host range of which was collected from different sources [9,10]. Taxonomic classification of Hutchinson was followed to analyze the relationships of different species of *Helicotylenchus* vis-à-vis host plants [11]. In this classification, angiosperms have been divided in two sub-phyllum- dicotyledons and monocotyledons which have been further classified in divisions viz., dicotyledons into lignosae (fundamentally woody plants) and herbaceae (fundamentally herbaceous plants), and monocotyledons into calyciferae (calyx bearer-with distinct calyx and corolla), corolliferae (calyx and corolla are more or less similar) and glumiflorae (perianth is much reduced or

Table 1: Distribution of host plants of *Helicotylechus* species in various groups of angiosperms.

Taxonomic group	Dicotyledons		Monocotyledons		Total
	Lignosae	Herbaceae	Calyciferae	Corolliferae	
No. of host species	302 (51.62)	103 (5.64)	33 (5.64)	63 (10.77)	585
No. of families	052 (54.74)	24 (25.26)	07 (7.37)	09 (9.47)	95
No. of orders	037 (56.06)	16 (24.24)	02 (3.03)	08 (12.12)	66

Table 2: Distribution of host plants of *Helicotylenchus* species in families and orders of angiosperms and gymnosperms.

Species	Host species	Families and their orders
<i>H. abunaamai</i>	5/5	Fabaceae(1)-Leguminales, Malvaceae(1)- Malvales, Vitaceae(1)-Rhamnales, Rutaceae(1)-Rutales, Anacardiaceae(1)-Sapindales (<i>Dicot-Lignosae</i>)
<i>H. anhelicus</i>	8/7	Annonaceae(1)-Annonales, Salicaceae(2)-Salicales, Betulaceae(1), Fagaceae(2)-Fagales, Theaceae(1)-Theales, Vitaceae(1)-Rhamnales (<i>Dicot-Lignosae</i>)
<i>H. australis</i>	1/1	Solanaceae(1)-Solanales (<i>Dicot-Herbaceae</i>)
<i>H. brevis</i>	1/1	Musaceae(1)-Zingiberales (<i>Monocot-Cal</i>)
<i>H. californicus</i>	12/9	Rosaceae(1)-Rosales, Urticaceae(1)-urticales, Tamaricaceae(2)-Tamaricales (<i>Dicot- Lignosae</i>), Asteraceae(4)-Asterales, Lamiaceae(2)-Lamiales (<i>Dicot- Herbaceae</i>), Araceae(1)-Arales (<i>Monocot-Cor</i>), Juncaceae(1)-Juncals (<i>Monocot -GLU</i>)
<i>H. canadensis</i>	1/1	Poaceae (1)-Graminales (<i>Monocot-Glu</i>)
<i>H. concavus</i>	1/1	Poaceae (1)-Graminales (<i>Monocot-Glu</i>)
<i>H. cavenessi</i>	1/1	Annonaceae(1)-Annonales (<i>Dicot-Lignosae</i>)
<i>H. conicephalus</i>	2/2	Vitaceae(1)-Rhamnales, Rutaceae(1)-Rutales (<i>Dicot-Lignosae</i>)
<i>H. coomansi</i>	1/1	Iridaceae(1)-Iridales (<i>Monocot-cor</i>)
<i>H. crenacauda</i>	3/3	Betulaceae(1)-Fagales (<i>Dicot-Lignosae</i>), Strelitziaceae(1), Musaceae(1)- Zingiberales (<i>Monocot-Call</i>)
<i>H. digonicus</i>	68/61	Magnoliaceae(1)-Magnoliales, Rosaceae(8)-Rosales, Fabaceae(7)-Leguminales, Caprifoliaceae(1)-Araliales, Juglandaceae(1)-Juglandales, Casuarinaceae(1)-Casuarinales, Nyctaginaceae(1)-Thymelaneales, Moraceae(1)-Urticales, Cactaceae(1)-Cactales, Malvaceae(2)-Malvales, Aquifoliaceae(1)-Celastrales, Vitaceae(1)-Rhamnales, Rutaceae(2)-Rutales, Sapindaceae(1)-Sapindales, Oleaceae(4)-Loganiales, Apocynaceae(1)-Apocynales (<i>Dicotlignosae</i>); Ranunculaceae(1)-Ranales, polygonaceae(1)-Polygonales, Chenopodiaceae(1)-Chenopodiales, Saxifragaceae(1)-Saxifragales, Asteraceae(1)-Asterales, Solanaceae(1), Convolvulaceae(2)-Solanales, Scrophulariaceae(1)-Pesonales (<i>Dicot- Herbaceae</i>); Zingiberaceae(1)-Zingiberales (<i>Monocot-cal</i>); Liliaceae (2)-Liliales, Araceae(1)-Arales, Amaryllidaceae(1)-Amaryllidales, Iridaceae(1)-Iridales, Agavaceae(1)-Agavales, Arecaceae(1)-Palmales (<i>Monocot-Cor</i>); Poaceae(11)-Graminales (<i>Monocot-Glu</i>); Cupressaceae(3), Pinaceae(1), Polypodaceae(1), Toxodiaceae(1) (<i>Gymnosperms</i>)
<i>H. densibullatus</i>	1/1	Lamaceae(1)-Lamiales (<i>Dicot-Herbaceae</i>)
<i>H. dihystrera</i>	249/189	Myrtaceae(3)-Myrtales, Aquifoliaceae(2), Celastraceae(1)-Celastrales, Vitaceae(2)-Rhamnales, Marsinaceae(1)-Marsinales, Ebenaceae(10)-Ebenales, Rutaceae(5)-Rutales, Aceraceae(1), Anacardiaceae(3), Sapindaceae(3)-Sapindales, Oleaceae(3)-Loganiales, Apogynaceae(3), Asclepiadaceae(1)-Apocynales, Rubiaceae(3)-Rubiales, Bignoniaceae(1)-Bignoniales (<i>Dicot-Lignosae</i>); Piperaceae(1)-Piperales, Caryophyllaceae(3)-Caryophyllales, Polygonaceae(1)-Polygonales, Chenopodiaceae(1)-Chenopodiales, Onagraceae(1)-Onagraceae, Crassulaceae(3)-Saxifragales, Apiaceae(2)-Umbellales, Asteraceae(6)-Asterales, Convolvulaceae(2), Solanaceae(5)-Solanales, Acanthaceae(1)-Personales, Geraniaceae(1)-Geraniales, Boraginaceae(1)-Boraginales, Lamiaceae(2), Myoporaceae(1)-Lamiales (<i>Dicot-Herbaceae</i>); Bromeliaceae(2)-Bromeliales, Cannaceae(1), Musaceae(4), Strelitziaceae(1), Zingiberaceae(2) (<i>Monocot-Cal</i>); Liliaceae(7)-Liliales, Araceae (10)-Arales, Amaryllidaceae(5)-Amaryllidales, Iridaceae(2)-Iridales, Agavaceae(3)-Agavales, Arecaceae(3)-Palmales, Orchidaceae(1)-Orchidales (<i>Monocot-Cor</i>); Cyperaceae(3)-Cyperales, Poaceae(26)-Graminales (<i>Monocot-Glu</i>); Araucareaceae(1), Cupressaceae(1), Pinaceae(9), Podocarpaceae(1)-Pinales, Cycadaceae(1)-Cycadales, Ginkgoaceae(1)-Ginkgoales, Polypodiaceae(1)-Polypodiales (<i>Gymnosperms</i>)

<i>H. dihysteroides</i>	1/1	Solanaceae(1)-Solanales (Dicot-Herbaceae)
<i>H. egyptiensis</i>	2/2	Musaceae(1)-Zingiberales (Monocot-Cal); Poaceae(1)-Graminales (Monocot-Glu)
<i>H. erythrinae</i>	90/79	Paeoniaceae(1)-Ranales, Piperaceae(1)-Piperales, Brassicaceae(2)-Brassicales, Polygonaceae(1)-Polygonales, Chenopodiaceae(1)-Chenopodiales, Apiaceae(2)-Umbellales, Asteraceae(4)-Asterales, Convolvulaceae(1), Solanaceae(3)-Solanales, Lamiaceae(1)-Lamiales (Dicot-Herbaceae); Bromeliaceae(1)-Bromeliales, Heliconiaceae(2), Marantaceae(1), Musaceae(2), Strelitziaceae(1), Zingiberaceae(1)-Zingiberales (Monocot-Cal); Liliaceae(2)-Liliales, Araceae(4)-Arales, Amaryllidaceae(1)-Amaryllidales, Agavaceae(1)-Agavales, Arecaceae(4)-Palmales (Monocot-Cor); Poaceae(9)-Graminales (Monocot-Glu); Cycadaceae(1)-Cycadales, Cupressaceae(1)-Pinales (Gymnosperms)
<i>H. indicus</i>	1/1	Fabaceae(1)-Leguminales (Dicot-Lignosae)
<i>H. intermedius</i>	1/1	Euphorbiaceae(1)-Euphorbiales (Dicot-Lignosae)
<i>H. lobus</i>	2/2	Fagaceae(1)-Fagales, Urticaceae(1)-Urticales (Dicot-Lignosae)
<i>H. macrostylus</i>	2/2	Fabaceae(2)-Leguminales (Dicot-Lignosae)
<i>H. microcephalus</i>	1/1	Poaceae(1)-Graminales (Monocot-Glu)
<i>H. microlobus</i>	35/30	Rosaceae(2)-Rosales, Fabaceae(4)-Leguminales, Cucurbitaceae(4)-Cucurbitales, Malvaceae(1)-Malvales (Dicot-Lignosae); Brassicaceae(3)-Brassicales, Chenopodiaceae(1)-Chenopodiales, Apiaceae(1)-Umbellales, Asteraceae(1)-Asterales, Solanaceae(4)-Solanales (Dicot-Herbaceae); Amaryllidaceae(1)-Amaryllidales (Monocot-Cor); Poaceae(13) (Monocot-Glu)
<i>H. multicinctus</i>	64/50	Rosaceae(1)-Rosales, Fabaceae(9)-Leguminales, Moraceae(1), Urticaceae(1)-Urticales, Nyctaginaceae(1)-Thymelaeales, Cucurbitaceae(4)-Cucurbitales, Malvaceae(7)-Malvales, Euphorbiaceae(2)-Euphorbiales, Ericaceae(1)-Ericales, Clusiaceae(1)-Guttiferales, Rutaceae(2)-Rutales, Aceraceae(1)-Sapindales, Pedaliaceae(1)-Bignoniales (Dicot-Lignosae); Brassicaceae(4)-Brassicales, Portucaceae(1)-Caryophyllales, Amaranthaceae(1), Chenopodiaceae(1)-Chenopodiales, Apiaceae(1)-Umbellales, Asteraceae(5)-Asterales, Convolvulaceae(1), Solanaceae(2)-Solanales (Dicot-Herbaceae); Musaceae(6)-Zingiberales (Monocot-Cal); Amaryllidaceae(3)-Amaryllidales, Arecaceae(1)-Palmales (Monocot-Cor); Poaceae(5)-Graminales (Monocot-Glu); Cupressaceae(1)-Pinales (Gymnosperms)
<i>H. neopaxille</i>	1/1	Oleaceae(1)-Loganiales (Dicot-Lignosae)
<i>H. oleae</i>	1/1	Oleaceae(1)-Loganiales (Dicot-Lignosae)
<i>H. orthosomaticus</i>	1/1	Fabaceae(1)-Leguminales (Dicot-Lignosae)
<i>H. pseudorobustus</i>	47/41	Rosaceae(1)-Rosales, Fabaceae(5)-Leguminales, Hydrangeaceae(1)-Cunoniales, Platanaceae(1)-Hamamelidiales, Salicaceae(1)-Salicales, Moraceae(2)-Urticales, Pittosporaceae(1)-Pittosporales, Theaceae(1)-Theales, Vacciniaceae(1)-Ericales, Celastraceae(1)-Celastrales, Vitaceae(1)-Rhamnales, Rutaceae(1)-Rutales, Oleaceae(2)-Loganiales, Rubiaceae(1)-Rubiales (Dicot-Lignosae); Brassicaceae(1)-Brassicales, Polagonaceae(1)-Polygonales, Chenopodiaceae(1), Phytolaccaceae(1)-Chenopodiales, Plantaginaceae(1)-Plantaginales, Asteraceae(2)-Asterales, Convolvulaceae(1)-Solanales (Dicot-Herbaceae); Cannaceae(1), Musaceae(1), Strelitziaceae(1)-Zingiberales (Monocot-Cal); Liliaceae(2)-Liliales, Araceae(2)-Arales, Typhaceae(1)-Typhales (Monocot-Cor); Poaceae(11)-Graminales (Monocot-Glu)
<i>H. talonus</i>	2/2	Lamaceae(1)-Lamiales (Dicot-Herbaceae); Musaceae(1)-Zingiberales (Monocot-Cal)
<i>H. tunisiensis</i>	1/1	Solanaceae(1)-Solanales (Dicot-Herbaceae)
<i>H. varicaudatus</i>	1/1	Musaceae(1)-Zingiberales (Monocot-Cal)
<i>H. willmottae</i>	1/1	Solanaceae(1)-Solanales (Dicot-Herbaceae)
<i>H. zeidani</i>	1/1	Poaceae(1)-Graminales (Monocot-Glu)

Table 3: Species wise host distribution of *Helicotylenchus* in various groups of angiosperms.

Species	Dicotyledons		Monocotyledons		Glumiflorae	Total
	Lignosae	Herbaceae	Calyciferae	Corolliferae		
<i>H. abunaamai</i>	5	0	0	0	0	5
<i>H. anhelicus</i>	8	0	0	0	0	8
<i>H. australis</i>	0	1	0	0	0	1
<i>H. brevis</i>	0	0	1	0	0	1
<i>H. californicus</i>	4	6	0	1	1	12
<i>H. canadensis</i>	0	0	0	0	1	1
<i>H. cavenessi</i>	1	0	0	0	0	1
<i>H. concavus</i>	0	0	0	0	1	1
<i>H. conicephalus</i>	2	0	0	0	0	2
<i>H. coomansi</i>	0	0	0	1	0	1
<i>H. crenacauda</i>	0	1	0	0	0	1
<i>H. densibullatus</i>	0	1	0	0	0	1
<i>H. digonicus</i>	34	9	1	7	11	62
<i>H. dihystra</i>	133	31	10	31	29	234
<i>H. dihystrides</i>	0	1	0	0	0	1
<i>H. egyptiensis</i>	0	0	1	0	1	2
<i>H. erythrinae</i>	42	17	8	12	9	88
<i>H. indicus</i>	1	0	0	0	0	1
<i>H. intermedius</i>	1	0	0	0	0	1
<i>H. lobus</i>	2	0	0	0	0	2
<i>H. macrostylus</i>	2	0	0	0	0	2
<i>H. microcephalus</i>	0	0	0	0	1	1
<i>H. microlobus</i>	11	10	0	1	13	35
<i>H. multicinctus</i>	32	16	6	4	5	63
<i>H. neopaxilli</i>	1	0	0	0	0	1
<i>H. oleae</i>	1	0	0	0	0	1
<i>H. orthosomaticus</i>	1	0	0	0	0	1
<i>H. pseudorobustus</i>	20	8	4	4	11	47
<i>H. talonus</i>	0	1	1	0	0	2
<i>H. tunisiensis</i>	0	1	0	0	0	1
<i>H. varicaudatus</i>	0	0	1	0	0	1
<i>H. willmottae</i>	0	1	0	0	0	1
<i>H. Zeidani</i>	0	0	0	0	1	1

represented by lodicules). Plant species reported as hosts of different species of *Helicotylenchus* were aligned with families and orders following the system of Hutchinson [11]. The information thus far available on the clades of this nematode species was also discussed [2]. The terms monophagous (feed on plants under single genus), oligophagous (feed on plants of different genera in a single family) and polyphagous (feeding wide range of plants under different plant families) were adopted as described by Bernays and Chapman [12].

Host Preference of *Helicotylenchus*

Information across the species elucidate that *Helicotylenchus* is

capable to parasitize 585 plant species and out of these around 69% are dicotyledons and rest monocotyledons. Lignosae (fundamentally woody plants) harbor 51.62% host species and 17.60% fall in herbaceae division. In monocotyledons, glumiflorae (14.36%) has more parasitized plants than corolliferae (10.77%) and calyciferae (5.64%). Number of families and orders follow the same trend as in the case of host species except in glumiflorae (Table 1).

The three most primitive plant families viz., Magnoliaceae, Annonaceae and Lauraceae are parasitized by 5 species only. For example, Magnoliaceae (Magnolales) is infested by *H. dihystra*

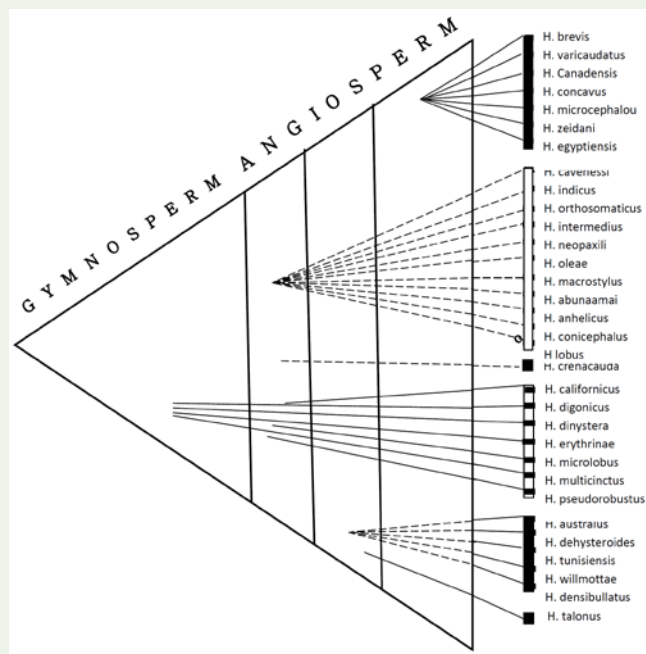


Figure 1: Relationship of 33 species of *Helicotylenchus* with their host groups.

and *H. digonicus*: Annonaceae (Annonales) by *H. anhelicus*, *H. concavus*, *H. dihystrera*, and Lauraceae (Laurales) by *H. erythrinae* and *H. dihystrera*. On the other hand, *H. dihystrera* parasitizes all the three families. Certain less common families like Tamaraceae and Juncaceae are parasitized by *H. californicus* only. Similarly, host families viz., Amaranthaceae, Clusiaceae and Pedaliaceae are infested by *H. multicinctus*; Typhaceae, Pittosporaceae and Vacciniaceae by *H. pseudorobustus*; Paeoniaceae and Punicaceae by *H. erythrinae*, and so on (Table 2).

The most preferred plant family is Poaceae which is parasitized by 11 *Helicotylenchus* species followed by Fabaceae 10, Solanaceae and Musaceae 9 each, and Asteraceae, Rosaceae and Rutaceae each sharing 7 species. These plant families also harbor maximum number of host plants (Table 3) which indicate towards diversified feeding behavior of this nematode.

Species specific affiliation to taxonomic groups and phylogenetic relationships

Species specific nature provides more diversified and different view. Among monocots, 7 species of *Helicotylenchus* (Table 2, Figure 1) are host specific. *Helicotylenchus brevis* and *H. varicaudatus* parasitize plants from musaceae: *H. coomansi* from Iridaceae, and *H. canadensis*, *H. concavus*, *H. microcephalus* and *H. zeidani* from Poaceae only. Similarly, in dicotyledons-lignosae, *H. cavenessi* parasitizes plants from Annonaceae; *H. indicus* and *H. orthosomaticus* from Fabaceae; *H. intermedius* from Euphorbiaceae, and *H. neopaxilli* and *H. oleae* from Oleaceae only. In herbceae 5 species are host specific. Out of these, *H. densibullatus* was parasitic on Lamiaceae, and *H. australis*, *H. dihystreroides*, *H. tunisiensis* and *H. willmottae* on Solanaceae. Since all the above mentioned species are host specific

and feed on single species of a given family, they are categorized as monophagous.

One species *H. macrostylus* is considered as oligophagous and others as polyphagous as they parasitize on plants from more than one genera of different families to many genera in different families and orders (Table 3).

Among the polyphagous species *H. californicus*, *H. microlobus* and *H. pseudorobustus* are inclined more towards dicotyledons as their host species are spread in 5, 9 and 21 families, respectively (Table 3, Figure 1). On evolutionary scale, host plants of the three species are distantly located.

Helicotylenchus dihystrera has large number of host species ranging from gymnosperm to all the divisions of dicots and monocots in angiosperms. Among gymnosperms, it parasitizes *Cycus* sp. (Cycadaceae), *Ginkgo* sp. (Ginkgoaceae), *Araucaria* sp. (Araucaceae), *Cupressus* sp. (Cupressaceae), *Abies* sp., *Pinus clausa*, *P. cubensis*, *P. echidna*, *P. elliotii*, *P. paulastris*, *P. taeda*, *P. rigida*, *pinus* sp. (Pinaceae), *Podocarpus* sp. (Podocarpaceae) and *Polypodiaceae* sp. (Polypodiaceae). Among the angiosperms, most primitive families Magnoliaceae (Magnoliales), Annonaceae (Annonales) and Lauraceae (Laurales) are parasitized by this nematode species. It is believed that ancestors of angiosperms diverged from unknown group of gymnosperms during late Triassic (245-202 million years ago) period [13,14]. Combined 3-and 4-gene rooted analysis by Bowe et al. reveal that cycads separated first from gymnosperm followed by Ginkgo and then (Gnetales + Pinaceae) sister to a monophyletic group with all other conifer families [15]. It also implies many similarities between gnetophytes and angiosperms. Hutchinson opined that derivation of flower structure from foliage leaves in Magnoliaceae is like the leaves

and sporophylls in the more ancient gymnosperms, Pinaceae, Cycads, etc [11]. Therefore, any gymnosperm plant on which *H. dihystra* feeds upon could be the progenitor of angiosperms and host species belonging to Magnoliaceae (primitive of fundamentally woody flowering plants) evolved from them. Two phylogenetic affiliations are evident with 4 taxonomic groupings which are as follows:

1. Gymnosperms--Magnoliales--Delleniales--Rosales--Hamamelidales--Fagales--Jugandales, Urticales
2. Gymnosperm—Magnoliales—Delleniales—Bixales—Tiliales—Malvales—Euphorbiales—Rhamnales—Myrsinales—Ebenales

However, in these two evolutionary lineages, no host species has been reported on Delleniales in the first, and on Delleniales and Bixales in the second. Delleniales are remotely related to the Magnoliales and show a connecting link between Magnoliales and Rosales, Bixales, etc. [11].

The taxonomic groups such as i) Rosales—Leguminales, ii) Rosales—Cunoniales—Araliales, salicales, iii) Theales—Ericales, and Loganiales—Rubiales, Apocynales, Bignoniales show close relationship and contribute a lot of host species.

In herbceae, the lineages are i) Saxifragales—Solanales—Personales, ii) Saxifragales—Caryophyllales—Onagrales, Chenopodiales, Polygonales. In monocots, order Liliales is a prolific stock and gave rise to several orders directly like Graminales, Iridales, Arales, and Agavales-Palmales. In dicotyledons-lignosae, host plants from diverse orders are selected, whereas in herbaceae some orders like Brassicales and its progenitors and descendents are totally rejected. Similarly, in monocots the orders evolved from Alismatales (an ancient group, corresponding to Ranunculaceae) are not parasitized.

Helicotylenchus digonicus parasitizes 6 species of gymnosperms (*Cupressus* sp., *Juniperus* sp., *Thuja* sp., *Pinus* sp., *Sequoia* sp. (Pinales) and *Polypodiaceae* sp. (Polypodiales) and 62 species of angiosperm. Thirty-four species belong to dicotyledons-lignosae, 9 dicotyledons-herbaceae and 19 monocotyledons (1 calyciferae, 7 corolliferae and 11 glumiflorae) embracing a total of 55 genera, 32 families and 31 orders. Parasitized host species, both in lignosae and herbaceae, are from most primitive families to advanced families in their respective orders. Families Rosaceae, Fabaceae and Poaceae dominate the host range. Herbaceae starts with Paeoniaceae (Ranales) as a parallelism of the Magnoliaceae (Magnoliales) of dicotyledons [11]. Therefore, gymnosperms are progenitor of this group also. Hence the evolutionary lineage was observed as:

Gymnosperms—Ranales—Saxifragales—Solanales—Personales

In monocots, Liliales serve as basal stock and give rise to 6 orders more or less directly. No host except in Zingiberales is parasitized in any other order evolved from Commelinales and Alismatales.

Helicotylenchus erythrinae is also is a polyphagous species and feeds on *Cycus* sp. and *Juniperus* sp. (Cupressaceae-Pinale) in gymnosperms. It parasitizes 88 host species from 77 genera in

angiosperms encompassing 23, 10, 6, 5 and 1 families in lignosae, herbaceae, calyciferae, corolliferae and glumiflorae, respectively, of dicots and monocots divisions. In both the divisions of dicots, infestation start from primitive families like Lauraceae (Laurales) in lignosae and Paeoniaceae (Ranales) in herbaceae which continue up to advanced groups. In lignosae orders viz., Rosales, Leguminales, Araliales, Salicales, Hamamelidales, Fagales, Jugandales and Urticales evolved from Rosaceous stock and Loganiales, Rubiales, Myrtales, Rutales, Celastrales and Sapindales from different taxonomic groups contributed for host range. In herbaceae also varied groups are preferred. Liliales stock dominate in monocots embracing 5 families in 5 orders, whereas Zingiberales alone contributed host species from 5 families. Family Poaceae has more parasitized plants than others.

In case of *H. multicinctus* no evolutionary or phylogenetic relationships are prominent. However, it preferred host species from various orders and showed close affinity with dicotyledons as well as monocotyledons.

Investigation on phylogenetic relationships within *Helicotylenchus* by Subbotin et al. revealed a lot of variation within the species and designated them as species types [2]. They recognized 9 clades of *Helicotylenchus*. Out of the species described here, *H. pseudorobustus* with its species types occupied Clade I; *H. digonicus* Clade I, V and IX; *H. dihystra* Clade II; *H. multicinctus* Clade III, and *H. brevis* Clade VII. Fortuner et al. opined *H. rotundicauda* as a synonym of *H. dihystra* [16]. Subbotin et al. also support the synonymy of *H. rotundicauda* with *H. dihystra* [2]. Samples of *H. dihystra* from West Africa (Sawadogo et al, 2009) clustered in Clade iii with *H. muticinctus* [17]. According to Bae et al. the aforesaid samples also clustered with *H. microlobus*. Sher synonymized *H. microlobus* with *H. pseudorobustus* [18]. On host front, *H. dihystra*, *H. digonicus*, *H. microlobus*, *H. multicinctus* and *H. pseudorobustus* are polyphagous and predominately prefer dicotyledonous plants. Taxonomic groupings also support their synonymy. *H. brevis* in Clade VII is monophagous and parasitize monocotyledons. It does not share any other *Helicotylenchus* species in this clade.

The information provided in preceding paragraphs on taxonomic groupings of host species has predictive value. In endemic areas, this will help in selection of appropriate varieties, formulation of better crop rotations, execution of important agronomic practices and adoption of better nematode management practices.

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