



## FREE LIVING AND PLANT PARASITIC SOIL NEMATODES (ORDERS DORYLAIMIDA AND TYLENCHIDA) OF HIMACHAL PRADESH, INDIA

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### INTRODUCTION

Himachal Pradesh is a state in Northern part of India with Shimla as the state capital. It is spread over 21,495 sq miles (55,670 km<sup>2</sup>), and is bordered by the states of Jammu and Kashmir on the north, Punjab on the west and south-west, Haryana and Uttar Pradesh on the south, Uttarakhand on the south-east. Himachal Pradesh is located between 30°10' to 33°12' north latitude and 75°47' to 79°04' east longitude. The state comprises of twelve districts – Shimla, Solan, Chamba, Hamirpur, Bilaspur, Kangra, Kullu, Mandi, Sirmour, Una, Kinnaur and Lahaul and Spiti. There are major divisions: the middle or central Himalayas comprising of Kinnaur, Kullu, Lahaul and Spiti and Pangi areas, the lesser Himalayas of Dhauladhar ranges and Shimla hills, Shivaliks of Sirmour, Bilaspur, Solan and Hamirpur districts and river terraces of different valleys like Kullu valley, and Una districts. It is a mountainous state with altitudes ranging from 350 to 69750 meters above the sea level. This wide variation in altitude with mountains, hills and valleys provides different climatic conditions leading to the cultivation of varieties of crops. Based on altitude, rainfall, temperature, humidity and topography, Himachal Pradesh has been divided into four agro-climatic Zones: subtropical sub-mountain and low hills, sub-temperate sub-humid hills, wet temperate high hills and dry temperate high hills and cold desert. The temperature and relative humidity range from 0-35°C and 50-80% respectively. Rainfall varies in between 350-1500 mm in different areas. Soil

type is mostly loamy sand, sandy loam, clay loam and silt loam.

Himachal Pradesh is a land of jade forests and fresh air. As much as 68% of the land area is covered with jungles. While the foothills and valleys are a refreshing green, the areas above the snow line are almost bare and desert type. The southernmost tracts are dominated by sal (*Shorea robusta*), sisham, chir pine, dry deciduous and moist broad-leafed forests. The temperate region above this grows oaks, deodar, blue pine, fir and spruce. In the uppermost climes, trees are sturdy with a vast network of roots (to help them tide over the weeks of burial under heavy snow). Alders, birches, rhododendrons and moist alpine scrubs are found in the name of vegetation. The tough rhododendron is an amazing plant of terrific importance in the ecological chain. About 70-80% population of the state are dependent on farming. The major agricultural crops are sub-tropical and temperate fruits among which apple is one of the most economically important fruit crop. Maize, rice, wheat, ginger, cucurbits, peas, potato, tomato, barley are grown in different seasons.

Among the soil-borne pests, soil free-living and plant-parasitic nematodes are generally overlooked due to their hidden nature and microscopic size. They multiply in millions and spread from place to place by different agricultural practices, causing great damage to the agricultural crops. They inhibit root growth, growth of plants affecting crop production and are thus responsible for massive yield losses. Due to this lack of awareness in

common people and farmers; the importance of nematodes in agriculture was overlooked in this state till 1951. Thirumalachar (1951) first recorded the occurrence of root-knot nematode on potato tubers for the first time from Shimla.

After 1951, extensive studies on taxonomy of tylenchid nematodes were done and several new species from Himachal Pradesh were described by different nematologists (Jairajpuri and Siddiqi, 1963a; Khan, 1964; Jairajpuri & Baqri, 1973; Saha *et al.*, 1973; Khan & Singh, 1974; Jairajpuri and Siddiqi, 1979; Sultan & Jairajpuri, 1978, 1979; Sultan, 1980; Khan & Khan, 1982; Khurma & Gupta, 1988 a, b; Sharma *et al.*, 1986). On the other hand, the study on nematodes belonging to the order Dorylaimida from Himachal Pradesh is comparatively less, although several new species have been described from the state (Jairajpuri & Siddiqi, 1963b; Ali *et al.*, 1974; Ahmad & Jairajpuri, 1979, 1980 and 1982; Baqri & Jairajpuri, 1974, 1975; Jairajpuri & Coomans, 1977).

Nematodes associated with different fruit plants in Himachal Pradesh have been studied by Mukhopadhyaya (1970), Bhardwaj & Sharma (1971), Chandel (1986) and by Sharma & Kaur (1986, 1987). Association of nematodes with mushroom was observed by Bhardwaj *et al.*, (1973) and Chandel (1982). A detailed information on plant nematology of Himachal Pradesh has been provided (Sharma & Gupta, 1998). Extensive work on the host record, occurrence, distribution and association of nematodes with different economically important agricultural and horticultural crops was done (Thirumalachar, 1951; Mukhopadhyaya, 1970; Dalal & Bhatti, 1983; Sharma *et al.*, 1984; Kaur, 1987; Sharma *et al.*, 1988; Khurma, 1989; Kaur *et al.*, 1989; Kaur *et al.*, 1990; Kaur & Sharma, 1990; Chandel, 1993)

The present study includes two systematic lists of soil free-living and plant-parasitic nematodes belonging to the orders Dorylaimida Pearse, 1942 and Tylenchida Thorne, 1949 from Himachal Pradesh. 34 species under 18 genera and 9 families of Dorylaimida and 83 species under 35 genera and

13 families of Tylenchida have been compiled and reported in this report. Among these, *Dorylaimus neominimus* Gantait *et al.* 2010, *Aporcelaimellus heynsi* Baqri and Jairajpuri, 1968., *Labronema glandosum* Rahman *et al.*, 1986, *Thonus garhwaliensis* Ahmad *et al.*, 1986, and the genera *Actinolaimoides* Meyl, 1957, *Laimydorus* Siddiqi, 1969 and *Indokochinema* Darekar and Khan, 1979 are new records from Himachal Pradesh. *Dorylaimus thornei* Andrassy, 1969 is the first report from India. Five species of Tylenchida i.e. *Polenchus shamimi* Baqri, 1991, *Rotylenchoides neoformis* (Siddiqi and Husain, 1964) Sher, 1966, *Rotylenchulus reniformis* Linford and Oliveira, 1940. *Tylenchorhynchus cylindricus* Cobb, 1913 and the genus *Filenchus* (Meyl, 1961) Andrassy, 1954 are new records from Himachal Pradesh. The respective species of the genera *Actinolaimoides*, *Laimydorus*, *Indokochinema* and *Filenchus* could not be confirmed. The classification proposed by Jairajpuri and Ahmad (1992) and by Siddiqi (2000) have been followed to arrange the available genera and species of Dorylaimida and Tylenchida respectively from Himachal Pradesh and to indicate their present taxonomic status.

## MATERIALS AND METHODS

*Processing of soil samples and extraction of nematodes:*

The collected soil samples were processed by Cobb's sieving and decantation technique (Cobb, 1918) followed by modified Baermann funnel technique (Christie and Perry, 1951) for extraction of nematodes. Soil sample of about 500gms was taken in a bucket of 10 liter capacity. The bucket was filled with clean water up to half of its capacity. The soil and water were thoroughly mixed by hand to make a homogeneous suspension. Stones and plant debris were removed. The muddy suspension was stirred very well by hand and left undisturbed for 20-30 seconds allowing the heavier particles to settle down at the bottom of the bucket while the nematodes and fine soil particles remained suspended in water. This suspension was passed through a coarse sieve and was collected in another bucket. The entire process was repeated thrice to

get a muddy suspension quite free from stones, large soil particles and other undesirable organic matter. This suspension was subjected to similar filtration, but through a fine sieve of 325 meshes. Most of the fine soil particles passed through this sieve but the nematodes and larger soil particles were retained on the surface of the sieve. This was again washed thoroughly with running water within the sieve to get rid of the soil particles as far as possible without losing the nematodes. Then the entire content of the sieve was collected in a beaker of 250 ml, by washing the sieve repeatedly with water, so that all nematodes could be collected.

Then a double layer of tissue paper was placed on an aluminium net of 2 mm pore size and was made moist by applying water gently without leaving any air gap or bubble between the layers of the tissue paper. Now, the aliquot, previously collected in the beaker, was poured gently on this moist double tissue paper supported by 2 mm pore size aluminium net and was further suspended in clean water in a petri dish. The aliquot on the tissue paper was covered by another petri dish to prevent evaporation and desiccation. The whole arrangement was left undisturbed for at least 24 hours.

The nematodes migrated downward through the tissue paper in the clear water of petri dish. This clear water containing nematodes was taken in a big test tube with the help of a dropper by washing the petri dish several times with clean water, so that no nematodes were left out in the petri dish. The water in test tubes, along with nematodes, was kept undisturbed for 2-3 hours, so that the nematodes in the water could settle down at the bottom of the test tube. Then most of the water in the test tube was withdrawn very carefully without disturbing the nematodes. Finally the entire nematode population along with 3-4 ml of water was taken after decantation of water.

#### *Fixation and Preservation of Nematodes:*

The nematodes, kept in 3-4 ml of water in the test tube, were killed and fixed instantly in their characteristic body posture by Seinhorst's method

(Seinhorst, 1966) in hot FA (formalin-acetic acid 4:1) solution, the composition of which was as follows:

Formalin (40% formaldehyde)	: 08 ml
Glacial acetic acid	: 02 ml
Distilled water	: 90 ml

These fixed nematodes were preserved in the same solution in properly labeled specimen tubes.

## RESULT

### List 1: Systemic Index of Dorylaimid Nematodes Available from Himachal Pradesh

- Phylum NEMATODA Rudolphi, 1808  
(Lankester, 1877)
- Order DORYLAIMIDA Pearse, 1942
- Suborder DORYLAIMINA Pearse, 1936
- Superfamily DORYLAIMOIDEA De Man, 1976
- 1. Family DORYLAIMIDAE De Man, 1976
- Subfamily DORYLAIMINAE De Man, 1976
- 1. Genus *Dorylaimus* Dujardin, 1845
- 1. *Dorylaimus innovatus* Jana and Baqri, 1982
- 2. *D. neominimus* Gantait *et al.*, 2010
- 3. *D. thornei* Andrassy, 1969
- Subfamily LAIMYDORINAE Andrassy, 1969
- 2. Genus *Laimydorus* Siddiqi, 1969
- 4. *Laimydorus* sp.
- 2. Family APORCELAIMIDAE Heyns, 1965
- Subfamily APORCELAIMINAE Heyns, 1965
- 3. Genus *Aporcelaimellus* Heyns, 1965
- 5. *Aporcelaimellus* sp.
- 6. *A. conicaudatus* (Altherr, 1953) Monterio, 1970
- 7. *A. heynsi* Baqri and Jairajpuri, 1968
- 3. Family QUDSIANEMATIDAE  
Jaurajpuri, 1965
- Subfamily QUDSIANEMATINAE  
Jaurajpuri, 1965
- 4. Genus *Indokochinema* Darekar and  
Khan, 1979

8. Genus *Indokochinema* sp.  
 5. Genus *Labronema* Thorne, 1939
9. *L. glandosum* Rahman *et al.*, 1986  
 6. Genus *Thonus* Thorne, 1974
10. *T. garhwaliensis* Ahmad *et al.*, 1986  
 4. Family NORDIIDAE Jairajpuri and Siddiqi, 1964  
 Subfamily PUNGENTINAE Siddiqi, 1969
7. Genus *Pungentus* Thorne & Swanger, 1936
11. *Pungentus clavatus* Ahmad & Jairajpuri, 1979  
 8. Genus *Enchodelus* Thorne, 1939  
 Subgenus *Enchodelus* Thorne, 1939
12. *Enchodelus (Enchodelus) distinctus* Ahmad & Jairajpuri, 1980
13. *E. (E.) microdoroides* Baqri & Jairajpuri, 1974  
 Subgenus *Nepalus* Ahmad & Jairajpuri, 1980
14. *Enchodelus (Nepalus) maximus* Baqri & Jairajpuri, 1974  
 Subgenus *Paraenchodelus* Ahmad & Jairajpuri, 1980
15. *Enchodelus (Paraenchodelus) longidens* Jairajpuri & Loof, 1968
16. *E. (P.) satendri* Baqri & Jairajpuri, 1968
17. *E. (P.) thornei* Baqri & Jairajpuri, 1974  
 Subgenus *Rotundus* Ahmad & Jairajpuri, 1980
18. *Enchodelus (Rotundus) parateres* Baqri & Jairajpuri, 1974  
 Subfamily ACTINOLAIMOIDINAE Meyl, 1957  
 9. Genus *Actinolaimoides* Meyl, 1957
19. Genus *Actinolaimoides* sp.  
 Superfamily LONGIDOROIDEA Thorne, 1935  
 5. Family LONGIDORIDAE Thorne, 1935  
 Subfamily LONGIDORINAE Thorne, 1935
10. Genus *Paralongidorus* Siddiqi, Hooper & Khan, 1963
20. Species *Paralongidorus citri* (Siddiqi, 1959) Siddiqi, Hooper & Khan, 1963  
 Syn. *Xiphinema citri* Siddiqi, 1959
11. Genus *Longidorus* Micoletzky, 1922
21. Species *Longidorus himalayansis* (Khan, 1986) Jairajpuri & Ahmad, 1992  
 Syn. *Neolongidorus himalayansis* Khan, 1986
22. *Longidorus elongates* (De Man, 1876) Thorne & Swanger, 1936  
*Dorylaimus elongatus* De Man, 1876
6. Family XIPHINEMATIDAE Dalmaso, 1969  
 Subfamily XIPHINEMATINAE Dalmaso, 1969  
 12. Genus *Xiphinema* Cobb, 1913
23. *Xiphinema* sp.
24. *Xiphinema americanum* Cobb, 1913
25. *X. basiri* Siddiqi, 1959  
 Syn. *X. cobbi* Sharma & Saxena, 1981  
 Syn. *X. hayati* Javed, 1983
26. *X. bergeri* Luc, 1973  
 Superfamily BELONDIROIDEA Thorne, 1939  
 7. Family BELONDIRIDAE Thorne, 1939  
 Subfamily BELONDIRINAE Thorne, 1939  
 7.13. Genus *Axonchium* Cobb, 1920  
 Subgenus *Axonchium* Cobb, 1920
27. *Axonchium (Axonchium) manalicum* Ali, Jairajpuri & Coomans, 1975  
 Subfamily DORYLAIMELLINAE Jairajpuri, 1964
14. Genus *Dorylaimellus* Cobb, 1913  
 Subgenus *Dorylaimellus* Cobb, 1913
28. *Dorylaimellus (Dorylaimellus) himalayensis* Ali, Jairajpuri & Coomans, 1974  
 Superfamily TYLENCHOLAIMOIDEA Filipjev, 1934  
 8. Family TYLENCHOLAIMIDAE Filipjev, 1934  
 Subfamily TYLEPTINAE Jairajpuri, 1964
15. Genus *Gymnotyleptus* Ahmad & Jairajpuri, 1982
29. *Gymnotyleptus gymnochilus* (Loof, 1964) Ahmad & Jairajpuri, 1982  
 Syn. *Tyleptus gymnochilus* Loof, 1964



30. *Gymnotyleptus indicus* Ahmad & Jairajpuri, 1982  
Superfamily NYGOLAIMOIDEA Thorne, 1935  
9. Family NYGOLAIMIDAE Thorne, 1935  
Subfamily NYGOLAIMINAE Thorne, 1935  
16. Genus *Aquatides* Heyns, 1968  
31. *Aquatids christicki* Ahmad & Jairajpuri, 1982  
32. *A. deconincki* Jairajpuri & Coomans, 1977  
17. Genus *Clavicaudoides* Heyns, 1968  
33. *Clavicaudoides tenuicaudatum* Ahmad & Jairajpuri, 1982  
18. Genus *Paravulvulus* Heyns, 1968  
34. Species *Paravulvulus papillatus* Ahmad & Jairajpuri, 1982

**List 2: Systemic Index of Tylenchid Nematodes Available From Himachal Pradesh**

- Class SECERNENTEA von Linstow, 1905  
Subclass TYLENCHIA Inglis, 1983  
Order TYLENCHIDA Thorne, 1949  
A] Suborder TYLENCHINA Chitwood in Chitwood Chitwood, 1950  
Infraorder TYLENCHATA Siddiqi, 2000  
Superfamily TYLENCHOIDEA Örley, 1880  
1. Family TYLENCHIDAE Örley, 1880  
Subfamily TYLENCHINAE Örley, 1880  
1. Genus *Tylenchus* Bastain, 1865  
1. Species *Tylenchus arcuatus* Siddiqi, 1963  
2. *T. elegans* De Man, 1876  
3. *T. magnus* Khurma & Gupta, 1988  
2. Genus *Aglenchus* Andrassy, 1954 (Meyl, 1961)  
4. Species *Aglenchus agricola* (De Man, 1884) Meyl, 1961  
5. *A. muktii* Phukan & Sanwal, 1980  
3. Genus *Coslenchus* Siddiqi, 1978  
6. Species *Coslenchus capsici* Khurma & Gupta, 1988

7. *C. costatus* (De Man, 1921) Siddiqi, 1978  
8. *C. indicus* (Khan, Chawla & Prasad, 1969) Siddiqi, 1978  
Syn. *Tylenchus (Aglenchus) indicus* Khan, Chawla & Prasad, 1969  
4. Genus *Filenchus* Andrassy, 1954 (Meyl, 1961)  
9. Species *Filenchus* sp.  
5. Genus *Polenchus* Andrassy, 1980  
10. Species *Polenchus shamimi* Baqri, 1991  
Subfamily BOLEODORINAE Khan, 1964  
6. Genus *Boleodorus* Thorne, 1941  
11. Species *Boleodorus mirus* Khan, 1964  
Subfamily DUOSULCIINAE Siddiqi, 1979  
7. Genus *Malenchus* Andrassy, 1968  
Subgenus *Malenchus* Andrassy, 1968  
12. Species *Malenchus (Malenchus)* sp.  
8. Genus *Ottolenchus* Husain & Khan, 1967 (Golden, 1971)  
13. Species *Ottolenchus eqisetus* (Husain & Khan, 1967) Wu, 1970  
Syn. *Ottolenchus purvus* (Siddiqi) Siddiqi, 1979  
Subfamily PLEUROTYLENCHINAE Andrassy, 1976  
9. Genus *Cephalenchus* Goodey, 1962 (Geraert, 1968)  
14. Species *Cephalenchus leptus* Siddiqi, 1963  
Infraorder ANGUINATA Siddiqi, 2000  
Superfamily ANGUINOIDEA Nicoll, 1935 (1926)  
2. Family ANGUINIDAE Nicoll, 1935 (1926)  
Subfamily ANGUININAE Nicoll, 1935 (1926)  
10. Genus *Ditylenchus* Filipjev, 1936  
15. Species *Ditylenchus myceliophagus* Goodey, 1958  
11. Genus *Nothotylenchus* Thorne, 1941  
16. Species *Nothotylenchus* sp.

12. Genus *Safianema* Siddiqi, 1980
17. Species *Safianema* sp.
- B] Suborder Hoplolaimina Chizhov & Berezina, 1988
- Superfamily HOPLOLAOMOIDEA Filipjev, 1934 (Paramonov, 1967)
3. Family HOPLOLAIMIDAE Filipjev, 1934
- Subfamily HOPLOLAIMINAE Filipjev, 1934
13. Genus *Hoplolaimus* von Daday, 1905
- Subgenus *Basirolaimus* Shamsi, 1979
18. Species *Hoplolaimus* (*Basirolaimus*) *chambus* Jairajpuri & Baqri, 1973
- Syn. *Hoplolaimus chambus* Jairajpuri & Baqri, 1973
- Syn. *Basirolaimus chambus* (Jairajpuri & Baqri, 1973) Siddiqi, 1986
19. *Hoplolaimus* (*Basirolaimus*) *indicus*
- Syn. *Hoplolaimus indicus* Sher, 1963
20. *Basirolaimus indicus* (Sher, 1963)
- Shamsi, 1979
14. Genus *Scutellonema* Andr assy, 1958
21. Species *Scutellonema brachyurus* (Steiner, 1938) Andr assy, 1958
- Syn. *Rotylenchus brachyurus* Steiner, 1938
- Subfamily ROTYLENCHOIDINAE Whitehead, 1958
15. Genus *Rotylenchoides* Whitehead, 1958
22. *Rotylenchoides neoformis* (Siddiqi and Husain, 1964) Sher, 1966
16. Genus *Helicotylenchus* Steiner, 1945
23. Species *Helicotylenchus borinquensis* Rom n, 1965 (*sp. inq.* For Fortuner *et al.*, 1981)
24. *H. girus* Saha *et al.*, 1973
25. *H. goldeni* Sultan & Jairajpuri, 1979
26. *H. rohtangus* Jairajpuri & Baqri, 1973 (Syn. of *H. retusus* for Lal & Khan, 1997)
27. *H. rotundicaudata* Sher, 1966 (Syn. Of *H. dihystra* for Fortuner *et al.*, 1981)
28. *H. shakili* Sultan, 1981
29. *H. vulgaris* Yuen, 1964
17. Genus *Orientalus* Jairajpuri & Siddiqi, 1977
30. Species *Orientalus geraerti* Jairajpuri & Siddiqi, 1979
- Syn. *Rotylenchus geraerti* (Jairajpuri & Siddiqi) Zancada & Lima, 1986
18. Genus *Rotylenchus* Filipjev, 1936
- Subgenus *Rotylenchus* Filipjev, 1936
31. Species *Rotylenchus* (*Rotylenchus*) *dalhousiensis* Sultan & Jairajpuri, 1979
32. *R. (R.) indorobustus* Jairajpuri & Baqri, 1973 (Syn. of *R. robustus* for Brzeski, 1998)
33. *R. (R.) neorobustus* Sultan & Jairajpuri, 1979
34. *Rotylenchus* (*Rotylenchus*) sp.
4. Family ROTYLENCHULIDAE Husain and Khan, 1957 (Husain, 1976)
- Subfamily ROTYLENCHULINAE Husain and Khan, 1967
19. Genus *Rotylenchulus* Linford and Oleiveira, 1940
35. Species *Rotylenchulus reniformis* Linford and Oleiveira, 1940
5. Family PRATYLENCHIDAE Thorne, 1949 (Siddiqi, 1963)
- SubFamily PRATYLENCHINAE Thorne, 1949
20. Genus *Pratylenchus* Filipjev, 1936
36. Species *Pratylenchus coffeae* (Zimmermann, 1898) Filipjev & Schurr. Stekh., 1941
- Syn. *Tylenchus coffeae* Zimmermann, 1898
37. *P. neglectus* (Rensch, 1924) Filipjev & Sch. Stekh., 1941
- Syn. *Aphelenchus neglectus* Rensch, 1924
- Syn. *Tylenchus neglectus* (Rensch) Steiner, 1928.
38. *P. neocapitatus* Khan & Singh, 1975
39. *P. penetrans* (Cobb, 1917) Filipjev & Sch. Stekh., 1941
- Syn. *Tylenchus penetrans* Cobb, 1917

40. *P. zae* Graham, 1951  
Syn. *P. impar* Khan & Singh, 1975
41. *Pratylenchus* sp.  
Subfamily HIRSCHMANNIELLANAE  
Fotedar & Handoo, 1978  
21. Genus *Hirschmanniella* Luc & Goodey, 1964
42. Species *Hirschmanniella mucronata* (Das, 1960) Khan, Siddiqi, Khan, Husain & Saxena, 1964  
Syn. *Radhopholus mucronata* Das, 1960
43. *H. oryzae* (Van Breda de Hann, 1902) Luc & Goodey, 1964  
Syn. *Tylenchus oryzae* Van Breda de Hann, 1902
6. Family MELOIDOGYNIDAE Skarbilovich, 1959 (Wouts, 1973)  
Subfamily MELOIDOGYNIDAE  
Skarbilovich, 1959  
22. Genus *Meloidogyne* Goeldi, 1892
44. Species *Meloidogyne arenaria* (Neal, 1889) Chitwood, 1949  
Syn. *Anguina arenaria* Neal, 1889
45. *M. graminicola* Goloden & Birchfield, 1965
46. *M. hapla* Chitwood, 1949
47. *M. incognita* (Kofoid & White, 1919) Chitwood, 1949  
Syn. *Oxyuris incognita* Kofoid & White, 1919  
Syn. *Heterodera incognita* (Kofoid & White) Sandground, 1923
48. *M. javanica* (Treub, 1885) Chitwood, 1949  
Syn. *Heterodera javanica* Treub, 1885  
7. Family HETERODERIDAE Filipjev & Schurr. Stekh., 1941 (Skarbilovich, 1947)  
Subfamily HETERODERINAE Filipjev & Schurr. Stekh., 1941  
23. Genus *Heterodera* Schmidt, 1871
49. Species *Heterodera avenae* Wollenweber, 1924
50. *H. trifolii* Goffart, 1932  
24. Genus *Globodera* Skarbilovich, 1959
51. Species *Globodera pallida* (Stone, 1973) Behrens, 1975  
Syn. *Heterodera pallida* Stone, 1973
52. *G. pseudorostochiensis* (Kirjanova, 1963) Mulvey & Stone, 1976  
Syn. *G. rostochiensis* Krall, 1978  
Syn. *Heterodera pseudorostochiensis* Kirjanova, 1963  
Superfamily DOLICHODOROIDEA Chitwood in Chitwood & Chitwood, 1950 (Siddiqi, 1968)
8. Family TELOTYLENCHIDAE Siddiqi, 1960  
Subfamily TELOTYLENCHINAE Siddiqi, 1960  
25. Genus *Quinisulcius* Siddiqi, 1971
53. Species *Quinisulcius capitatus* (Allen, 1955) Siddiqi, 1971  
Syn. *Tylenchorhynchus capitatus* Allen, 1955
54. *Q. indicus* Luqman & Khan, 1986  
26. Genus *Tylenchorhynchus* Cobb, 1913
55. Species *Tylenchorhynchus clarus* Allen, 1955
56. *T. cylindricus* Cobb, 1913
57. *T. mashhoodi* Siddiqi & Basir, 1959  
Syn. *Macrorhynchus mashhoodi* (Siddiqi & Basir) Sultan, Singh & sakuja, 1991
58. *Tylenchorhynchus* sp.  
27. Genus *Bitylenchus* Filipjev, 1934  
Syn. *Tylenchus* (Bitylenchus) Filipjev, 1934
59. Species *Bitylenchus brevilineatus* (Williams, 1960) Jairajpuri, 1982  
Syn. *Tylenchorhynchus brevilineatus* Williams, 1960
60. *Bitylenchus* n. sp.  
Subfamily MERLINIINAE Siddiqi, 1971  
28. Genus *Merlinius* Siddiqi, 1970
61. Species *Merlinius nothus* (Allen, 1955) Siddiqi, 1970  
Syn. *Tylenchorhynchus nothus* Allen., 1955

62. *M. nizami* Luqman & Khan, 1986
63. *Merlinius* sp.
9. Family PSILENCHIDAE Paramonov, 1967  
(Khan, 1969)
- Subfamily PSILENCHINAE Paramonov, 1967
29. Genus *Psilenchus* De Man, 1921
64. Species *Psilenchus aestuarius* Andr ssy, 1962
65. *P. hilarulus* De Man, 1921
66. *P. hilarus* Siddiqi, 1963
- Syn. *Psilenchus neoformis* Jairajpuri & A.  
H. Siddiqi, 1963
- C] Suborder CRICONEMATINA Siddiqi, 1980
- Superfamily CRICONEMATOIDEA Taylor,  
1936 (1914) Geraert, 1966
10. Family CRICONEMATIDAE Taylor, 1936  
(1914) Thorne, 1949
- Subfamily CRICONEMATINAE Taylor, 1936  
(1914)
30. Genus *Ogma* Southern, 1914
- Subgenus *Ogma* Southern, 1914
67. Species *Ogma (Ogma) simlaensis* (Jairajpuri,  
1963) Andr ssy, 1979
- Syn. *Variasquamata rhosimum* Khan, Chawla  
Chawla & Saha., 1976
31. Genus *Macroposthonia* De Man, 1880
68. Species *Macroposthonia bilaspurensis*  
Gupta & Gupta, 1981
69. *M. curvata* (Raski, 1952) De Grisse &  
Loof, 1965
- Syn. *Criconemella curvata* Raski, 1952
70. *M. xenoplax* (Raski, 1952) De Grisse &  
Loof, 1965
- Syn. *Criconemoides xenoplax* Raski., 1952
- Subfamily HEMICRICONEMOIDINAE  
Andr ssy, 1979
32. Genus *Hemicriconemoides* Chitwood &  
Birchfield, 1957
71. Species *Hemicriconemoides gaddi* (Loos,  
1949) Chitwood & Birchfield, 1957
- Syn. *Criconemoides gaddi* Loos., 1949
72. *H. mangiferae* Siddiqi, 1961
- Syn. *H. litchi* Edward & Misra., 1964
- Syn. *H. aberrans* Phuukan & Sanwal., 1983
- Superfamily HEMICYCLIOPHOROIDEA  
Skarbilovich, 1959 (Siddiqi, 1980)
11. Family HEMICYCLIOPHOROIDEA  
Skarbilovich, 1959 (Geraert, 1966)
- Subfamily HEMICYCLIOPHOROINAE  
Skarbilovich, 1959
33. Genus *Hemicycliophora* De Man, 1921
73. Species *Hemicycliophora subaolica*  
Jairajpuri & Baqri, 1973
74. *Hemicycliophora* sp.
- Superfamily TYLENCHULOIDEA  
Skarbilovich, 1947 (Raski & Siddiqi, 1975)
12. Family TYLENCHULOIDEA Skarbilovich,  
1947 (Kirjanova, 1955)
- Subfamily TYLENCHULOINAE Skarbilovich,  
1947
34. Genus *Tylenchulus* Cobb, 1913
75. Species *Tylenchulus semipenetrans* Cobb,  
1913
13. Family PARATYLENCHIDAE Thorne,  
1949 (Raski, 1962)
- Subfamily PARATYLENCHINAE  
Thorne, 1949
35. Genus *Paratylenchus* Micoletzky, 1922
- Subgenus *Gracilacus* Raski, 1962  
(Siddiqi, 1986)
- Syn. *Gracilpaurus* Ganguly & Khan., 1990
76. Species *Paratylenchus (Gracilacus) aonli*  
Misra & Edward, 1971
- Syn. *Gracilacus aonli* (Misra & Edward)  
Raski., 1976
- Subgenus *Paratylenchus* Micoletzky, 1922
77. *Paratylenchus (Paratylenchus) colbrani*  
*colbrani* Raski, 1975



78. *P. (P.) elachistus* Steiner, 1949  
 79. *P. (P.) lepidus* Raski, 1975  
 80. *P. (P.) minor* Sharma & Khan, 1986  
 81. *P. (P.) nanus* Cobb, 1923  
 82. *P. (P.) runii* Sharma & Khan, 1986  
 83. *P. (P.) vandenbrandei* De Grisse, 1962

### DISCUSSION

The study on nematodes started in Himachal Pradesh with the report of Thirumalahar (1951) about the infestation of root-knot nematode on potato tubers for the first time from Shimla and subsequently, the first nematology unit was established at Central Potato Research Institute, Shimla. A total of 138 nematode species under 63 genera belonging to Dorylaimida, Tylenchida and other nematode orders have been reported from Himachal Pradesh of which 45 species were described as new (Sharma & Gupta, 1998). Sharma & Kaur (1987) observed the parasitism of root-knot nematode *Meloidogyne* sp. on apple which is one of the most economically important cash crops of Himachal Pradesh. The species of root-knot nematodes like *Meloidogyne incognita*, *M. hapla* and *M. javanica* are the most prominent pest of potato and this nematode has been found to be prevalent in about 60% of the potato growing areas of Himachal Pradesh (Krishna Prasad, 1986) and prevalence and intensity of root-knot nematode infection on potato has also been observed (Krishna Prasad & Rajendran, 1986). *Quinisulcius capitatus* has also been suspected as potential pest of potato (Krishna Prasad, 1986; Khan *et al.*, 1990). The infestation of *Meloidogyne* spp. on tomato in Solan area has also been observed (Bharadwaj *et al.*, 1974). *Meloidogyne incognita* and *M. hapla* are the only recognized pests of vegetable crops in the state and these nematodes have been reported to occur in 50 – 100% of vegetable fields of Himachal Pradesh (Bharadwaj *et al.*, 1974; Reddy, 1989). *Tylenchorhynchus* and *Helicotylenchus* have been reported to occur on ginger being highly prevalent (Kaur *et al.*, 1989). Saharan and Chohan (1972) surveyed the disease of plants due to nematodes in Kangra district of

the state. *Tylenchorhynchus* spp., *Macroposthonia xenoplex*, *Meloidogyne incognita*, *Pratylenchus pratensis*, *Helicotylenchus* spp., *Paratylenchus* sp. and *Xiphinema* sp. have been observed to occur on agricultural, horticultural and forest trees (Sharma *et al.*, 1982, Anonymous, 1993; Chandel, 1993). *Meloidogyne incognita*, *M. hapla*, *Pratylenchus penetrans*, *P. coffeae*, *Paratylenchus prunii*, *Tylenchulus semipenetrans*, *Macroposthonia xenoplex* and *Ditylenchus myceliophagus* are the most important nematode species which cause enormous yield losses in various economically important agricultural and horticultural crops and the wide spread occurrence of *Heterodera zae*, *Quinisulcius capitatus*, *Tylenchorhynchus*, *Helicotylenchus* and *Xiphinema* in a number of agricultural and horticultural crops also cause direct or indirect crop losses (Sharma & Gupta, 1998). In the present study, 34 species under 18 genera and 9 families of Dorylaimida and 83 species under 35 genera and 12 families of Tylenchida have been compiled and reported. Among these, *Dorylaimus neominimus* Gantait *et al.* 2010, *Laimydorus* sp., *Aporcelaimellus heynsi* Baqri and Jairajpuri, 1968., *Indokochinema* sp., *Labronema glandosum* Rahman *et al.*, 1986, *Thonus garhwaliensis* Ahmad *et al.*, 1986, *Actinolaimoides* sp. are new rerecords from Himachal Pradesh and *Dorylaimus thornei* Andrassy, 1969 is the first report from India. Five species of Tylenchida i.e. *Polenchus shamimi* Baqri, 1991, *Filenchus* sp., *Rotylenchoides neoformis* (Siddiqi and Husain, 1964) Sher, 1966, *Rotylenchulus reniformis* Linford and Oliveira, 1940 and *Tylenchorhynchus cylindricus* Cobb, 1913 are new records from Himachal Pradesh.

### SUMMARY

The present study includes two systematic lists of soil free living and plant parasitic nematodes belonging to the orders Dorylaimida Pearse, 1942 and Tylenchida Thorne, 1949 from Himachal Pradesh. 34 species under 18 genera and 9 families of Dorylaimida and 83 species under 35 genera and 13 families of Tylenchida have been compiled and reported. Among these, *Dorylaimus neominimus* Gantait *et al.* 2010, *Laimydorus* sp.,

*Aporcelaimellus heynsi* Baqri and Jairajpuri, 1968., *Indokochinema* sp., *Labronema glandosum* Rahman *et al.*, 1986, *Thonus garhwaliensis* Ahmad *et al.*, 1986, *Actinolaimoides* sp. are new rerecords from Himachal Pradesh and *Dorylaimus thornei* Andrassy, 1969 is the first report from India. Five species of Tylenchida i.e. *Polenchus shamimi* Baqri, 1991, *Filenchus* sp., *Rotylenchoides neoformis* (Siddiqi and Husain, 1964) Sher, 1966, *Rotylenchulus reniformis* Linford and Oliveira, 1940 and *Tylenchorhynchus cylindricus* Cobb, 1913 are new records from Himachal Pradesh.

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