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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^2), 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, Sirmaur, 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 Hiamirpur 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 35genera 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 Oleiveira, 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 Andrássy, 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 Jauirajpuri, 1965

Subfamily QUDSIANEMATINAE Jauirajpuri, 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 & Jairajpiri, 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 Dalmasso, 1969

Subfamily XIPHINEMATINAE Dalmasso, 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 ***Paravulvus*** Heyns, 1968

34. Species *Paravulvus 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*** Andrássy, 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*** Andrássy, 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*** Andrássy, 1968

Subgenus ***Malenchus*** Andrássy, 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 Andrássy, 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*** Andrássy, 1958

21. Species *Scutellonema brachyurus* (Steiner, 1938) Andrássy, 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* Román, 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. dihystera* for Fortuner *et al*., 1981)

28. *H. shakili* Sultan, 1981

29. *H. vulgaris* Yuen, 1964

17. Genus ***Orientylus*** Jairajpuri & Siddiqi, 1977

30. Species *Orientylus 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. zeae* 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 *Heteroder aavenae* 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 & sakhuja, 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* Andrássy, 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* (Jairajpiri, 1963) Andrássy, 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 Andrássy, 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 HEMICYCLIOPHOROIDAE 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 TYLENCHULOIDAE 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

Subjenus ***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 zeae, 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 35genera 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 Oleiveira, 1940 and *Tylenchorhynchus cylindricus* Cobb, 1913are 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 35genera 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 Oleiveira, 1940 and *Tylenchorhynchus cylindricus* Cobb, 1913are new records from Himachal Pradesh.

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