INTRODUCTION

Nematodes are not only diversified group of animals but like viruses, bacteria and insects occupy all the biotopes. They have developed in unimaginable numbers and in wide varieties of shapes. Every inch of this earth we live on, the large bodies of water surrounding us, rivers, pools, ponds and puddles are all inhabited by these tiny creatures. There are nematodes free-living in marine and freshwaters, soil-inhabiting and parasites of plants and animals. The parasitic forms are of considerable agricultural importance as pests of plants, and of medical and veterinary importance as parasites of man and livestock.

While our knowledge of nematode parasites of man and animals goes back to antiquity but the existence of plant parasites remained unknown until the 17th century. This is easy to visualise because of the fact that zoo-parasitic nematodes are large in body size and also the diseases they cause to man and animals commanded more attention. The plant-parasitic nematodes remained unobserved perhaps because of their exceedingly small size, lack of colour, mostly underground habitat and the difficulties encountered in their isolation. Nematode damage to plants was either ignored or confused with lack of soil fertility, soil erosion, improper irrigation facilities, and the poor quality
of seed. In addition, the symptoms of nematode attack are not usually obvious because neither they are spectacular nor clear-cut but slow to manifest spreading very gradually in extent year after year.

Williams Shakespeare might have given us unintentionally the first information of plant-parasitic nematode in the year 1594 when in Love's Labour's Lost, Act IV, Scene 3, he wrote the line "Sowed cockle, reap'd no corn". However, it was Needham (1743) who solved this mystery when he teased a diseased wheat grain and examined it under his primitive microscope in a drop of water. This is how the wheat gall nematode, Anguina tritici was discovered. This historic report was followed by two important discoveries of the plant parasites. In 1855, Berkeley determined a root-knot nematode, Meloidogyne sp., attacking cucumber plants in England; and in 1859 Schacht discovered a serious disease caused to sugar beets in Germany by a nematode which was later named Heterodera schachtii by Schmidt (1871).

Since the dawn of the 20th century several important contributions have been made by Cobb, de Man, Nicoletzky, Filipjev, Goodeys, Steiner, Coffart, Chitwoods, Taylor, Thorne, de Coninck, Oostenbrink, Franklin and others. Their efforts and scientific contributions have led to the emergence of Plant Nematology as an independent branch of biology. This is no doubt a great step forward. The
researches have now clearly demonstrated that all plants are susceptible to attack by one or the other species of nematode. These animals can withstand a wide range of environmental conditions and can easily spread from one place to another by movements of plants, soil and contaminated objects. Besides doing direct damage to plants, the nematodes may act in association with bacteria and fungi producing disease complex, and in certain cases they may spread viral infections to their hosts. In the recent years, several procedures have been developed to control these pests. However, most of these methods are costly and beyond the use of ordinary farmers. The application of control methods is also quite intricate. Crop rotation is perhaps a more successful approach. In fact, much remains to be done in this field.

In India considerable work was done during the last 4 decades on the zoo-parasitic nematodes of vertebrates as well as of invertebrates. Major contributions in this field were made by Bhalerao, Thapar, Mirza, Singh, Basir, Ali and others. However, the study of plant and soil nematodes started in this country only when their economic importance became fully established through the researches conducted in countries like United States, United Kingdom and the Netherlands. Important contributions in this field were made only during the last decade by Das, Siddiqi, Seshadri and Khera. Prior
to 1959 only a few references are available on Indian species of plant-parasitic nematodes. Butler (1913) described *Ditylenchus angustus* found associated with the dangerous 'ufra' disease of rice in Bengal. Cobb (1913) reported a species of *Criconema* (now *Hemicriconemoides*) associated with mango tree in Bangalore, South India. The gall forming nematodes, *Anguina tritici* and *Nothanguina occidentalis* were also reported from this country. Thomas (1948) reported *Pratylenchus* sp., attacking coffee seedlings in South India. Sanwal (1951) described a species of *Heliodogyne* from brinjal and Singh (1952) gave a check list of hosts of this genus in Uttar Pradesh. Goodey (1953) described two new species, *Ditylenchus drepnoneurus* and *Apheleschoideus asperocelphalum* from Indian soils.

The Department of Zoology of the Aligarh Muslim University is the first centre of Plant Nematology which has attained the status of a full-fledged Section on Nematology with Post Graduate teaching and research facilities leading to Ph.D. and D.Sc. degrees. It is heartening to see that in the recent years some of the universities and research institutes in India have introduced teaching and research in Plant Nematology. The Government of India has shown its awareness by creating an independent Division of Nematology at the Indian Agricultural Research Institute, New Delhi. During the year 1964 an International Course in Nematology was
organised at the I.A.R.I., New Delhi, and during the years 1967-70 three Post Graduate Nematology Courses were organised jointly by the Aligarh Muslim University, I.A.R.I., and the State Agricultural University, Wageningen, the Netherlands. A number of students from India as well as from South Asian countries participated in these courses and obtained training. As a result of these activities a number of personnel from different parts of our country were trained. It is now estimated that approximately 150 Indian plant nematologists are actively engaged in teaching and research in different parts of the country. It may be interesting to note that although started late, but the progress of Plant Nematology has been very spectacular. Much more work has been done during the last decade on plant and soil nematodes than on animal nematodes in the corresponding period. Agricultural importance of the group may be largely responsible for this progress, but another convincing reason is that Plant Nematology offered a virgin field of research to the workers.

The present writer began study of the plant-parasitic and soil-inhabiting nematodes during the year 1961, a time when very little work was done in this country. The nature of work was mainly taxonomic and morphological. Such studies are of fundamental importance because they provide a basis for experimental work, e.g., biology, ecology, physiology, control etc. Although essentially linked with
taxonomic work, the morphological study has its own importance. Due to paucity of informations on the biology, physiology, biochemistry, etc., of nematodes the morphology so far is the main basis of identification.

The taxonomy of nematodes in general has undergone considerable expansion during the last two decades. However, when compared with other invertebrate groups like Insecta, it is still in very early stages. According to Filipjev about 4,500 species of nematodes were described by the end of the year 1930, and by 1950 some 9,000. The present estimates raise it to over 11,000 described species. This is in fact a fraction of all those existing. It was speculated by Cobb that every kind of vertebrate is infested with usually more than one kind of nematode species. As we have some 50,000 species of vertebrates, they would harbour some 100,000 nematode species. To these must be added the aquatic forms, soil-inhabiting, plant parasites and those inhabiting invertebrates like molluscs, crustaceans, insects, centipedes, millipedes, annelids etc. Summing them all, it would perhaps be a fair estimate to consider at least 500,000 species of nematodes in the world. Out of this vast number only about 11,000 species are known. Thus nearly 98% of them await discovery. This clearly shows how poor is our present day knowledge and how much remains to be explored. One should, therefore, not be astonished and suspicious with
the rapid increase in the number of nematode species which is taking place these days.

An ideal classification of any group of animals should be convenient to work with and should reflect natural inter-relationship among the taxa. Such a system would be easy to formulate for those groups where a large number of species are already known, e.g., Insecta, birds and mammals. As far as nematodes are concerned, where much remains to be explored, the inter-relationships are difficult to be established. Consequently, the nematode systematic is mainly a matter of convenience of the taxonomists and would remain so for a number of decades to come.

The universal occurrence of the plant and soil nematodes and their phyto-parasitic nature has been mainly responsible for the considerable attention which this group has received. Upto 1950 there were only 46 genera with 250 described species under the taxa which contain plant parasites. The figures rose to 111 genera and 1079 species by the end of the year 1966. This rapid addition is definitely encouraging but it has problems of its own. Sufficient studies on the intra-specific variations have not been done and thus the stability of many important diagnostic characters is largely unknown. In some of the papers presented in this thesis an effort has been made to evaluate the validity of certain taxonomic characters. This was only possible by introducing an elaborate and broad-
based description of the taxa concerned, using a large number of specimens representing several populations obtained from different localities and hosts.

The present thesis envisages the results obtained by the present writer on his research on plant-parasitic and soil-inhabiting nematodes since 1961. This study, though mostly restricted to Indian forms, also includes materials from countries like United States, United Kingdom, the Netherlands, Switzerland, Nigeria, Morocco, Malawi, Mauritius, Pakistan, Malaysia etc. Contents of the thesis fall under three known Orders—Tylenchida, Araeolaimida and Dorylaimida, and a new Order Mononchida. Over one hundred new species and a large number of new combinations of species have been proposed under 17 new and 45 known genera. In addition, 14 new subfamilies, 8 new families, and 2 new superfamilies are erected. A large number of genera and known species have been reviewed together with emended diagnoses and key to species.

The Order Tylenchida includes the description of 16 new species under the families Tylenchidae, Hoplolaimidae, Criconematidae, and Neotylenchidae. A new subgenus, **Clavilenchus** under the genus **Tylenchus** has been proposed. The species, **Boleodorus indicus** deserved a generic status because of the unique feature of the dorsally spiral curvature of the body and consequently the genus **Dorsalle** has been
proposed for it. Two new genera, Paurodontoides under Paurodontidae and Scutylrenchus under Hoploaimidae are erected. The classification of the new superfamily Nectylenchoidea has been revised and enlarged so as to include the new family Nothotylenchidae and the new subfamily Halenchinae. Telotylenchus is synonymised with Trichotylenchus, Telotylenchidae with Belonolaiminae, and Rotylenchoidinae with Hoploaiminae. The morphology and biology of Anphelenchus avenae are worked out in detail.

Under the Order Ancyloaimida two papers have been published. The first one provides a review of the genus Chronogaster with the addition of two new species to it. The second paper gives detailed morphological studies of the genus Aulolaimus and declares Pandurinema as its synonym. Besides, a new subfamily Aulolaiminae has been proposed for the genera Aulolaimus and Pseudaulolaimus. The same paper also contains the intra-specific variations of Aulolaimus oxycephalus based on material obtained from different parts of the world.

The Order Dorylaimida forms the bulk of the thesis. Seventy six new species, thirteen new genera, ten new subfamilies and two new families have been proposed under this Order. In addition, a large number of new combinations of species, redescriptions, reviews on genera and records of species
so far undescribed from India, are the other notable
features. The new genera Basirotyrleptus, Borella, Costen-
brinkiella, Metadorylaimus, Drepanodorylaimus, Cudsiella,
Cephalodorylaimus, Purinosa etc., are unique among dorylaimid
nematodes. Basirotyrleptus has a fine needle-like spear and
its occurrence in high densities around plants suggests
that it might be a potential plant parasite. The taxonomy
of the genera Thornenema and Dorylaimoides have been consi-
derably simplified and stabilised by the addition of new
genera Willinema and Morasia respectively. The observations
on the genera Nortia, Lonsidorella and Thornedia are rather
interesting. The status of Tylencholaimus has been clarified
and new dimensions have been introduced into its taxonomy
with the addition of eight new species. A large number of
species belonging to the following families have been
described: Dorylaimidae, Leptonchidae, Actinolaimidae,
Belonolaimidae, Nygolaimidae, Aporcelaimidae etc.

The present writer has started a monographic series
on the nematodes of the new Order Mononchida. First three
papers of this series are included in this thesis. This
Order contains one of the most interesting groups of
nematodes with predatory habits, and thereby, maintain a
natural balance of the soil micro-organisms. They feed
efficiently on protozoans, rotifers, tardigrades, minute
oligochaetes and also on different kinds of nematodes
including phyto-parasitic forms. This habit has been
useful in some instances to reduce to considerable extent the populations of certain species of plant-parasitic nematodes. Exploited intelligently, we can utilise the group as useful tools in the Biological Control of the phytoparasitic nematodes. It is with this idea in mind that the present writer is currently working on Mononchida. The classification of the group has been suitably expanded to bring it at par with Tylenchida and Dorylaimida by proposing 5 new families, viz., Mononchulidae, Mylonchulidae, Cobbonchidae, Anatonicidae and Itonchidae.

Further two new subfamilies are proposed under the family Mylonchulidae—Mylonchulinae and Sporonchulinae. The genus Hadronchus has been redefined together with additions of two new species. Under the genus Itonchus, two new and a known species have been recorded, and under Miconchus one new and one known species. The genus Mononchus has been split up into Mononchus (sensu stricto) and Clarkonchulus n. gen. Some known species of these two genera are recorded from India. Mononchus monhystera is transferred to the genus Itonchus. Six new and five known species belonging to the genus Mylonchulus have been described. Key to the species of the genera Hadronchus, Itonchus, Miconchus, Mononchus, Clarkonchulus and Mylonchulus have been provided.

Three papers on the helminth parasites of reptiles and birds have been supplemented with this thesis. A new species of the trematode genus Uvitellina has been described together
with remarks on the related genera. The dracunculid nematode, *Necronleura indica* is recorded from a new host and its life history in cyclops has been worked out. The subgenus *Yorkeiapirura* under the genus *Oxyapirura* has been raised to the generic rank. A new species has been added to the genus *Oxyapirura*.

The contents of the thesis form the basis of 61 papers. This also includes five abstracts of full papers, published in the Proceedings of symposia. However, they have not been incorporated because full papers were ultimately published and these papers have been included.