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A REVIEW ON THE INDIAN SPECIES OF ANGUINIDAE (NEMATODA)

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ABSTRACT

Plant parasitic nematodes belonging to the family Anguinidae are either fungal feeder or feed on the aerial parts of the plants, exception being *Subanguina radicicola*. This group created the history in the Nematology being *Anguina tritici* the first ever recorded plant parasitic nematode, which causes seed gall disease on wheat. Another genus under this family, *Ditylenchus* is of great economic importance. From India, forty species of Anguinidae has been reported, of which 34 species belongs to the genus *Ditylenchus,* 3 of *Subanguina,* 2 of *Anguina* and 1 of *Indoditylenchus*. A proper identification needs comparison of all the morphometric characters, which generally remains scattered in different journals, and becomes inaccessible many a time. Moreover, the genera under this group have been synonymised with other by many workers. Therefore, attempts have been made to review this family and to collect all the information on Indian species of Anguinidae and to prepare this compendium for the researchers.

INTRODUCTION

Plant parasitic nematodes belonging to the family Anguinidae (Order: Tylenchida) are commonly referred to as anguinids. They are either fungal feeders or feed on aerial parts of plants, except *Subanguina radicicola*, which forms galls on root of graminaceous plants. As parasites of aerial plant parts, they mostly form galls. The family Anguinidae includes some economically important genera like *Anguina* Scopoli, 1777; *Ditylenchus* Filipjev, 1936; *Nothanguina* Whitehead, 1959; *Afrina* Brzeski, 1981; *Orrina* Brzeski, 1981 and *Subanguina* Paramonav, 1967. *Anguina tritici* (Steinbuch, 1799) Filipjev, 1936; the first plant parasitic nematode ever recorded (Needham, 1743) is responsible for causing ear cockle disease for wheat, though there is a mention of presence of this nematode in Shakespeare's (1598) drama "Love's Labour Lost". In his drama, he mentioned, "sowed cockle reaped no corn", which according to Thorne (1961) is a reference to ear cockle of wheat. Earlier this nematode was prevalent in almost all the wheat growing countries of the world, but due to adoption of proper seed cleaning process, this nematode is almost eliminated from developed countries and is now present only in some developing and underdeveloped countries, like Ethiopia, India, Pakistan, Romania, Syria and former Yugoslavia. Milne (1919) first reported this nematode from India. Infestation of *A. tritici* has been observed in all the wheat growing states of India like Bihar, Delhi, Haryana, Himachal Pradesh, Madhya Pradesh, Rajasthan, Punjab and Uttar Pradesh (Koshy and Swarup, 1971) and is responsible for 1-9 per cent yield loss in wheat (Paruthi and Bhatti, 1981).

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It has been reported that ear cockle nematode of wheat at a low level of infestation (< 1 per cent) causes an annual loss of Rs. 75,000,000 (Bhatti and Singh, 1992). The incidence of this nematode has come down considerably in states like Haryana and Punjab due to the use of certified seeds and is a problem of poor and marginal farmers only who use their own seeds. This nematode caused havoc in Bihar during 1997-1998 resulting in heavy yield loss, and many farmers had to burn their standing crops. Besides wheat, it has been reported on barley in Iraq, infesting 90 per cent population of barley (Al- Talib *et al*., 1986). Apart from causing ear cockle disease, this nematode in association with a bacterium, *Clavibacter tritici* causes yellow ear rot or "tundu" disease of wheat. *A. tritici* is also reported to carry spores of fungus, *Dilophosphora alopecuri* to the growing points and floral primordial of wheat. *A. agrotis* (Steinbuch, 1799) Filipjev, 1936 is responsible for production of galls on flower and seeds of many grasses like *Poa* sp., *Lolium* sp., *Agrotis* sp., etc in Europe, New Zealand, Australia and USA. *A. agrotis*, in association with the bacterium, *C. rathaya* is responsible for the production of corynetoxin in rye grass that causes nervous breakdown in livestock on consumption of rye grass in some parts of Australia.

Subanguina radicicola (Greeff, 1872) Paramonav, 1967 the only known anguinid that parasites root, is responsible for growth reduction of wheat and barley in Europe.

A number of *Ditylenchus* species are of great economic importance. They are either fungal feeder on aerial parts of plant or in roots, stolon, tubers and rhizomes. *D. angustus* (Butler, 1913) Filipjev, 1936 causing "ufra" disease of rice is one of the most economically important nematode. This nematode was first reported by Bulter (1913) from the head of Bay of Bengal, (now in Bangladesh). This nematode has been reported from Bangladesh, India, Madagascar, Malaysia,

Myanmar, Phillippines, Thailand, UAE and Veitnam. In India, this nematode has been reported from Assam, Maharashtra, Orissa, Uttar Pradesh and West Bengal. The area infested with *D. angustus* worldwide was estimated to be 10 million acres with an average yield loss of 30 per cent (Hollis and Keoboonrueng, 1984). This nematode is responsible for 20 - 90 per cent yield loss in Southern Thailand (Hashioka, 1963), 50 per cent in Uttar Pradesh, India (Singh, 1953) and 10 - 30 per cent in West Bengal and Assam of India (Rao *et al*., 1986). The stem and bulb nematode, D. *dipsaci* (Kuhn, 1857) Filipjev, 1936 is one of the most devastating plant parasitic nematode. The nematode is reported to attack more than 400 crop plants grown mainly in sub-tropical and temperate regions of the world. This nematode proved to be great menace in 1920s when it wiped out the narcissus industry in Britain. It causes seedling mortality ranging from 20 per cent in sugar beet and tomato to 100 per cent in onion (Griffin, 1975; Griffin *et al*., 1975). In Italy, up to 60 per cent seedling mortality in onion was reported due to *D. dipsaci* infestation, whereas for garlic, it was 50 per cent. In France and Poland, more than 90 per cent seedling mortality in garlic was recorded (Sturhan and Brzeski, 1991). *D. dipsaci* is also responsible for transmission of *Corynebacterium insidiosum*, a bacterium, which causes wilt disease of alfalfa (Hawn, 1963). This nematode is doubtfully reported from India by Rahman (1963) from Meghalaya, though it is under quarantine law. Tuber dry rot or tuber nematode, *D. destructor* Thorne, 1945 is a serious nematode pest of potato in Bangladesh, Canada, Canary Island, China, Hawaii, Iran, Japan, New Zealand, Pakistan, Peru, South Africa, USA and USSR. In Western Ukraine, these nematode causes a loss to a tune of 1,62,000 MT per annum (Webster, 1972). Besides potato, this nematode is reported to attack bulbous iris, mint rhizomes, sugar beet, carrot and parsley. *D. myceliophagus* Goodey, 1958, the mushroom nematode, is a serious nematode pest occurring in all mushroom growing counties of the world, particularly in temperate areas of Australia, Bulgaria, China, England, France, India, Japan, Malta, Netherlands, Poland, Sudan, USA and USSR, causing great loss to the mushroom cultivation. Sturhan and Brzeski (1991) reported yield reduction of 30, 50 and 75 per cent and even complete yield loss. In recent study, 18.87 per cent yield loss in button mushroom, *Agaricus bisporus,* due to *D. myceliophagus* has been reported (Vats and Bajaj, personal communication).

Some species of Anguinidae are important as biological control agents. *Orrina* (= *Nothanguina* = *Ditylenchus*) *phyllobia* Brzeski, 1981 can be used to control noxious weed *Solanum elaeagnifolium*, a perennial weed in cotton cultivation in South West USA (Robinson *et al*., 1978; Siddiqi, 1986). *Subanguina picridis* Kirjanov, 1944 can be used effectively in controlling *Acroptilon repens* (Russian knapweed), an economically troublesome weed in Canada (Watson, 1986a).

Different species of Anguinidae are indeed economically important and correct identification of the species of this group is, therefore essential. Siddiqi (1986) recorded 149 species of anguinids from the world over. Presently, 40 anguinids occur in India (2 species of *Anguina*, 34 species of *Ditylenchus*, 3 species of *Subanguina*, 1 species of *Indoditylenchus*, Sinha, Chaudhury and Baqri, 1985).

A taxonomic Review on Anguinidae

Needham (1743) made the beginning of the history of Phytonematology by reporting the wheat eelworm. He observed some fibers bundled together coming alive from a dry wheat seed when placed in water. He wrote to the President, Royal Society of London on 22 December, 1743 about his discovery and considered them as aquatic animals. Linnaeus (1764) included this organism under the genus *Chaos* in his book ***Systema Naturae***. Later, this nematode was proved to be the casual agent of ear cockle disease of wheat by Roffredi (1775). The genus *Anguina* was first proposed by Scopoli (1777) as *Angvina* for this nematode, but he did not give any specific name. Steinbuch (1799), however, named it as *Vibrio tritici* and described another nematode *V. agrostis* from grasses. Hardy (1850) added another species, *V. graminis* to this genus. Later on, all *Vibrio* species were transferred to the genus *Anguina*. In 1859, Gervais and Van Beneden assigned a new generic name to wheat eel-worm, *Anguillulina*. Bastian (1865) placed this nematode under the genus *Tylenchus.* Baylis and Daubeny (1926) and Goodey (1932, 1933) considered *Tylenchus* and *Anguina* as synonym of *Anguillulina*. Filipjev (1934) mentioned two subgenera of *Tylenchus, Tylenchus* (*Anguillulina*) for wheat eel-worm and *Tylenchus* (*Tylenchus*) for *T. davainei*. In 1935, Chitwood re- established the validity of the name *Anguina* and thus, the genus *Anguillulina* became its junior objective synonym. He recognized *Tylenchus* as different from *Anguina* or *Anguillulina*. Filipjev (1936) re-established the genera *Tylenchus, Tylenchorhynchus* Cobb, 1913 and *Anguina*. He also proposed two new genera *Ditylenchus* and *Tylenchus* and included *Ditylenchus* and *Anguina* under Tylenchinae.

Baylis and Daubeny (1926) proposed a family Anguillulinidae that was replaced to Anguinidae by Nicoll (1935). These families then included several genera like *Heterodera, Hoplolaimus, Tylenchulus, Aphelenchus, Tylopharynx* that are now placed in other families.

During 1935-1960, a number of genera (*Halenchus* Cobb in Cobb, 1933, *Ditylenchus, Paranguina* Kirjanova, 1955, *Sychnotylenchus* Ruhm, 1956, *Pseudhalenchu*s Tarjan, 1958 and *Nothanguina* Whitehead, 1959) were described. *Ditylenchus, Pseudhalenchus, Halenchus* and *Paranguina* were proposed under sub family Tylenchinae and *Nothanguina* under Nothotylenchinae (Tylenchida). Thorne (1961) classified *Tylenchus, Anguina Pseudhalenchus* and *Paranguina* under Tylenchinae and *Nothanguina, Nothotylenchus* Thorne, 1941 and *Halenchus* Nothotylenchinae. Paramonov (1962) restricted subfamily Anguininae only those genera that form galls on aerial parts of the plants, *viz., Anguina, Nothanguina* and *Paranguina*, and placed this subfamily under the family Tylenchidae. In 1963, Goodey placed *Anguina, Ditylenchus, Paranguina, Pseudhalenchus, Neoditylenchus* Meyl, 1961, *Sychnotylenchus* under Tylenchidae (without any subfamily)

and put *Nothotylenchus, Halenchus, Nothanguina* and *Thada* under Nothotylenchinae (Neotylenchidae). Paramonov (1967) proposed a new genus *Subanguina* that forms terminal galls on root under Aguininae and also proposed a subfamily Sychnotylenchinae to accommodate insect associated nematode genus *Sychnotylenchus*.

Wu (1967 a, b) studied the relationship between *Tylenchus, Ditylenchus* and *Anguina*, and treated these genera as members of Tylenchinae. She redefined *Ditylenchus* and *Anguina* on the basis of length of crustaformeria in relation to the length of spermatheca. Though she placed these three genera under Tylenchinae, but her studies later formed a basis to separate *Tylenchus* from *Ditylenchus* and *Anguina*.

In 1969, a new genus *Diptenchus* was proposed by Khan *et al.* under Tylenchidae from India.

Golden (1971) proposed a separate subfamily Ditylenchinae along with Anguinae and Sychnotylenchinae under Tylenchidae. Anguininae consisted of gall forming genera *Anguina, Subanguina, Paranguina*; Ditylenchinae contained *Ditylenchus, Pseudhalenchus, Diptenchus*; and Sychnotylenchinae contained *Sychnotylenchus* and *Neoditylenchus*. Siddiqi (1971) considered Anguinidae as distinct family with Anguininae, Pseudhalenchinae and Sychnotylenchinae as subfamilies. He included *Ditylenchus* under Anguininae and thus long association of *Ditylenchus* with *Tylenchus* under Tylenchinae/ Tylenchidae came to an end. Choi and Loof (1973) studied the status of *Ditylenchus* and *Anguina* and synonymised *Subanguina* with *Anguina*. A new genus *Cynipanguina* was proposed by Maggenti *et al.* (1974) that had digit- like basal extension of the oesophagus. Hirschmann (1975) again placed *Ditylenchus* under Tylenchinae. Hooper (1978) considered Ditylenchinae as a synonym of Anguininae. A new subfamily Nothanguininae was proposed by Fotedar and Handoo (1978) with the genus *Nothanguina* as type genus and placed under Nothotylenchidae.

Siddiqi (1980 a) raised Anguinidae to the super familial level and included Anguinidae, Nothotylenchidae and Sychnotylenchidae under it. However, Eliava *et al*. (1980) recognized Anguininae with *Anguina, Paranguina, Cynipanguina, Subanguina, Diptenchus, Pseudhalenchus* and *Ditylenchus* and monotypic subfamily Sychnotylenchinae under the family Anguinidae. Skarbilovich (1980) raised Ditylenchinae to the family level and included Ditylenchinae (genera: *Ditylenchus, Diptenchus*) and Sychnotylenchinae (genera: *Sychnotylenchus, Neoditylenchus*) in it. Siddiqi (1980 b) created a new genus *Safianema* that forms gall on oak plant and whose females have a prominent vulval flap, and placed it under Anguininae. He removed *Pseudhalenchus* from Anguinidae and placed it under Tylenchidae on the basis of structure of female gonad, sperm and spicule size.

Brzeski (1981) redefined the family Anguinidae and did not recognize any subfamily under it. He created major changes in the classification and Anguinids by considering that presence and absence of refractive thickenings in median bulb has no significance at generic level, accordingly synonymised Nothotylenchidae with Anguinidae. He included various genera in this family on the basis of structure of crustaformeria and proposed two new genera, *Afrina* and *Orrina* along with *Anguina, Subanguina, Ditylenchus, Nothanguina, Diptenchus, Nothotylenchus* and synonymised *Paraguina* and *Cynipanguina* with *Anguina*. *Safianema* and *Heteroanguina* Chizhov, 1980 were considered to be the junior synonyms of *Subanguina*. Raski and Maggenti (1983) proposed regrouping of Atylenchidae, Anguinidae, Ecphyadophoriade, Neotylenchidae, Paurodontidae, Nothotylenchidae and Psilenchidae under one category. This concept raised great doubt about the validity of the families Anguinidae, Atylenchidae and Neotylenchidae. Fortuner (1984) considered three families *viz*., Anguinidae (Anguininae, Pseudhalenchinae, Cynipanguininae), Sychnotylenchidae (Sychnotylenchinae, Neoditylenchinae) and Ditylenchidae (Ditylenchinae) under Anguinoidea and placed Nothanguininae in Nothanguinidae under Neotylenchoidea. Ganguly and Khan (1985) mentioned that members of Anguinidae were similar to that of Tylenchidae except for mode of parasitism, which they considered as adaptive character and rejected the creation of Anguinidae. Sinha *et al.* (1985) described one new genus *Indoditylenchus* under Anguinidae from India.

Chizhov and Subbotin (1985) reviewed Anguininae including *Anguina, Paranguina, Heteroanguina, Subanguina* and *Mesoanguina* Chizhov and Subbotin, 1985 and recognized only two subfamilies- Anguininae and Ditylenchinae. They classified Anguininae on the basis of hosts (monocotyledons, dicotyledons), infective stage (J2, J3 and J4), nature of galls (with cavity or without cavity), site of gall formation and number of generations completed within galls. Thus, they tried to correlate the phylogeny of this group with the evolution of plants. Siddiqi (1986) included Anguinidae under Hexatylina due to their association with fungi and/ or aerial parts of plants. Anguinidae included three subfamilies *viz*., Anguininae (genera: *Anguina, Subanguina, Cynipanguina, Pseudhalenchus, Diptenchus, Ditylenchus, Safianema*), Nothanguininae (genera: *Nothtylenchus, Orrina, Hadrodenus* Mulvey, 1969 and *Pterotylenchus* Siddiqi and Lanne, 1984). But, Maggenti *et al.*(1987) did not agree with Siddiqi's proposal for the formation of Hexatylina and placed Anguinidae again in Tylenchina. They also rejected all subfamilies under Anguinidae. Fortuner and Maggenti (1987) redifiened the family Anguinidae and considered *Anguina, Halenchus, Ditylenchus, Pseudhalenchus, Sychnotylenchus, Thada, Subanguina, Cynipanguina* and *Pterotylenchus* as valid genera under Anguinidae. They synonymised *Paranguina* and *Nothanguina* with *Anguina*; *Nothotylenchus*, *Boleodoroides* Mathur *et al*., 1966, *Diptenchus, Safianema* and *Orrina* with *Ditylenchus*; *Afrina, Heteroanguina* and *Mesoanguina* with *Subanguina*; and *Neoditylenchus* with *Sychnotylenchus*. Krall (1991) included *Anguina, Mesoanguina, Heteroanguina, Subanguina, Nothanguina, Pterotylenchus* and *Orrina* under Anguinidae.

Siddiqi (2000) revised the classification of Tylenchida and formed two infraorders, Tylenchata and Anguinata under Tylenchia. Anguinata contained a single super family

Anguinoidea; with two families Anguinidae and Sychnotylenchidae. Anguindae comprised two subfamilies, Anguininae (*Anguina, Diptenchus, Ditylenchus, Indoditylenchus, Nothanguina, Nothotylenchus, Orrina, Pseudhalenchus, Pterotylenchus, Safianema* and *Subanguina*) and Halenchinae (*Halenchus*). Sychnotylenchidae contained *Sychnotylenchus* and *Neoditylenchus* under Sychnotylenchinae.

Table 1 Measurements of Indian species of Anguinids

Sl No	Species	MB	LL	L	a	b	c	c'	V	Spear	PUS	Spic	Gube	Bursa	Lip	Tail tip	Remarks
1	*D. acuminatus*	+	4	0.55	31.9	4.9	10.5	5	81.1	6.0	0.88	-	-	-	Cont.	acute	-
2	*D. anchilisposomus*	+	6	0.62	33.9	4.7	12.3	0	81	8.8	2.0	18	6	61	Cont.	round	Long Oesophageal
3	*D. angustus*	+	4	1.00	56.0	7.5	21.0	5.3	79.0	10.5	2.25	18.1	8	100	Cont	mucronate	-
4	*D. ausafi*	+	4	0.56	26.5	6.2	9.5	5.8	73.5	10.5	1.7	14	6	33	Offset	Sub-acute	Ovary reaching
5	*D. brassicae*	+	4	0.45	39.0	4.6	9.0	6.5	74.0	8.5	0.6	-	-	-	Cont.	sub-acute	Outer incisures crenate
6	*D. cyperi*	+	5	0.58	23.5	5.8	17.5	2.5	79.0	10.5	?	16	8	91	Cont.	sub-acute	-
7	*D. emus*	+	4	0.90	40.0	6.5	13.5	4.6	66.0	8.0	1.25	16	5.0	33	Cont.	sub-acute	Outer incisures crenate
8	*D. solani*	+	4	0.94	53.0	7.5	13.0	6.5	81.5	9.5	2	19	5.5	20	Cont.	sub-acute	No cephalic sclerotization
9	*D. indicus*	+	4	0.75	36.5	5.1	12.0	5.0	82.0	11.5	1.5	14	6.7	33	Cont.	acuminate	-
10	*D. khani*	+	5	0.95	37.5	7.5	13.5	5.0	84.0	8.5	0	22	8.0	67	Cont.	acute	No post vulval uterine sac
11	*D. medicaginis*	+	6	0.87	43	5.7	9.8	7.4	80	7.2	1.8	17.3	6.0	33	Cont.	rounded	Median bulb with weak
12	*D. myceliophagus*	+	6	0.99	33.8	8.6	15.5	4	82.0	7.5	2.5	20	5.5	75	Cont.	rounded	-
13	*D. mirus*	+	6	0.63	34.5	6.3	18.5	2.3	84.0	8.5	1.9	17	6.0	76	Offset	rounded	-
14	*D. nanus*	+	6	0.54	33.5	6.6	18.0	2.9	83.5	7.3	2.5	14	5.5	84	Offset	rounded	-
15	*D. trifomis*	+	6	0.74	37.9	6.3	10.8	4.5	78.5	8.5	1.0	14	5.5	42	Offset	round-dull	-
16	*D. hisarensis*	+	4	1.10	39.5	8.9	13.8	5.3	83.9	9.0	1.0	21	6.0	30	Cont.	pointed	Posterior half of tail tapering
17	*D. zeae*	+	6	0.75	35.9	5.4	14.9	4.0	83.4	9.0	1.7	21	6.0	74	Cont.	rounded	MB=28.9
18	*D. acutus*	-	4	0.45	25.0	5.0	9.5	6.0	73.2	8.0	1.8	14	4.5	33	Cont	pointed	-
19	*D. basiri*	-	4	0.43	26.0	4.5	9.6	5.0	74.1	6.5	2.3	14	4.3	40	Oont.	rounded	Ovary reaching
20	*D. bhatnagari*	-	4	0.65	?	?	14.5	?	81.0	9.5	1.0	18	5.5	50	Cont.	rounded	-
21	*D. cylindricus*	-	4	0.56	33.0	4.8	10.7	4.8	79.4	7.5	1.5	14	4.0	26	Cont.	rounded	No cephalic sclerotization
22	*D. buckleyi*	-	6	0.43	24.4	?	11.2	5.0	71.2	11.0	2.5	15	?	33	Cont.	pointed	-
23	*D. oryzeae*	-	6	0.75	45.5	7.7	9.0	5.5	75.0	8.5	1.5	20	4	36	Cont.	clavatre	Oocytes in multiple rows
24	*D. hexaglyphus*	-	6	0.69	32.5	5.9	12.1	4.8	82.5	8.0	0.88	-	-	-	Cont.	rounded	Oocytes in multiple rows
25	*D. taylori*	-	6	0.55	36.5	5.7	10.5	6.5	76.0	8.5	2.5	20	5.5	60	Cont.	rounded	Outer incisures crenate
26	*D. citri*	-	6	0.78	45.0	6.2	13.5	5.0	79.0	9.0	2.0	21	6.5	75	Cont.	sub-acute	Oesophagel lumen forms
27	*D. fotedari*	-	6	0.65	24.5	5.5	15.0	4.0	85.0	9.0	1.0	17	5	25	Cont.	pointed	Oocytes arranged in
28	*D. phyllobius*	-	7	0.67	21.9	8.1	14.3	3.5	84.4	11.5	1.7	19	7.1	68	Offset	pointed	Male tail with digitate
29	*D. similes*	-	4	0.70	34.6	7.1	10.0	7.0	80.6	9.5	1.5	19	6.0	33	Cont.	sub-acute	Basal bulb with stem like
30	*D. varaprasadi*	-	6	0.75	39.5	6.5	13.0	4.5	79.5	7.0	1.1	20	9.0	50	Cont.t	rounded	Oocytes arranges in
31	*D. floricus*	+	Ind	0.87	35.3	7.3	19.1	3.7	87.1	9.0	1.2	-	-	-	offset	Mucronate	-
32	*D.robustus*	-	Ind	0.48	17.8	4.6	10.2	3.1	80.7	10.4	0.34	-	-	-	Cont.	Pointed	-
33	*D.triticus.*	-	Ind	0.58	27.6	6.6	8.9	4.4	81.5	8.9	0.3	-	-	-	Cont	Rounded	-
34	*A. tritici*	+	4/>4	3.2	18.0	14.0	36.4	-	80.7	10.0	1.6	32	16	67	Offset	Rounded	Occytes arranged
35	*S. chrysopogoni*	+	Ind	1.7	26.8	10.2	30.4	3.6	92.2	7.5	1.1	32	15.0	100	offset	Mucronate	-
36	*S. minuta*	+	Ind	0.55	17.0	5.7	11.3	3.8	80.2	8.0	0.7	16	6.0	29	offset	Pointed rounded	-
37	*S. neominuta.*	+	Ind	0.63	25.3	6.3	10.8	4.7	77.1	10.0	1.4	14	5	36	offset	Rounded	Post vulval uterine sac
38	*I. sundarbanensis*	+	?	0.86	43.0	6.2	8.0	5.5	81.0	12.3	0.7	20	7.5	33	Cont.	Rounded	-
39	*A. cecidoplastes*	+	Ind	1.62	15.5	11.0	24.8	2.7	90.5	6.5	0.7	24.5	-	50	offset	Digitate	-
40	*D. bhattii*	+	4	0.74	33.2	6.3	10.3	4.7	81.9	11.7	1.2	19.1	5	40	Cont.	Dull-pointed	Crustaformeria with 5 cell in

Table 2 Detail reference of the Indian species of Anguinids

Sl No	Species Name	Reference	Synonym
1	*Ditylenchus acuminatus* Fortuner &Maggenti,1987	Bull.Ent *(1971) 12:55-58*	*Pseudhalenchus acutus* Khan & Nanjappa,1972; *D. acutus* (Khan & Nanjappa,1972) Fortuner,1982 nec *Nothotylenchus acutus* Khan,1965
2	*D. anchilisposomus* (Tarjan, 1958) Fortuner,1982	Proc Helminth. Soc. Wash.*(1958) 25:21-25*	*Pseudhalenchus anchilisposomus* Tarjan,1958; *Safianema anchilisposomus* (Tarjan,1958) Siddiqi,1980
3	*D. angustus* (Butler,1913) Filipjev,1936	CIH Descriptions of Plant-parasitic Nematodes Set5	*Tylenchus angustus* Butler ,1913; *Anguillulina angusta* (Butler,1913) Goodey,1932
4	*D. ausafi* Hussain & Khan,1967	Proc. Helminth. Soc. Wash *(1967) 34:175-186*	------
5	*D. brassicae* Hussain & Khan ,1975	Indian J. Nematol. *(1975) 5:49-55*	-------
6	*D. Cyperi* Hussain & Khan, 1967	Proc .Helminth. Soc.Wash *(1967) 34:175-186*	-------
7	*D. emus* Khan *et al*., 1969	Labdev.J.Sci.Technol. *(1969)7B 311-314*	-------
8	*D. solani* Hussain & Khan, 1976	Indian J.Nematol.*(1976) 5:49-55.*	-----
9	*D. indicus* (Sethi & Swarup, 1967) Fortuner, 1982	Indian Phytopathology *(1967)20:26-28*	*Pseudhalenchus indicus* Sethi & Swarup,1967; *Safianema indicum* (Sethi & Swarup,1967) Siddiqi,1986
10	*D. khani* Fortuner,1982	Nematologica *(1969) 15:337-340*	*Diptenchus indicus* Khan *et al.* 1969 nec *Ditylenchus indicus* (Sethi & Swarup,1967)Fortuner,1982.
11	*D. medicaginis* Wasilewska ,1965	-----	--------
12	*D. myceliophagus* Goodey,1958	CIH description of Plant parasitic Nematodes Set. 3	---------
13	*D. mirus* Siddiqi, 1963	z.f. Parasitenkunde *(1963) 23:397-404*	--------
14	*D. nanus* Siddiqi,1963	Z. ParisitKde.*(1963) 23:39-404*	--------
15	*D. triformis* Hirschmann & Sasser, 1955	Proc. Helminth. Soc. Wash *(1955) 22:115-123.*	--------
16	*D. hisarensis* Das and Bajaj, 2005	Indian J. Nematol *(2005)* 35 (1) : 11-35	---------
17	*D. zeae* Das and Bajaj, 2005	Indian J. Nematol *(2005)* 35 (1) : 11-35	---------
18	*D. acutus* (Khan,1965)Fortuner& Maggenti,1987	Proc.Helminth.Soc.Wash.*(1965) 32:90-93*	*Nothotylenchus indicus* Saxena *et al.*1973 nec *D.indicus* (Sethi& Swarup,1967)Fortuner,1982; *Nothotylenchus paramonovi* Gagarin,1974; *D. paramonovi* (Gagarin,1974) Fortuner and Maggenti, 1987
19	*D. basiri* (Khan,1965)Fortuner & Maggenti,1987	Proc.Helminth.Soc.Wash*(1965) 32:90-93*	*Nothotylenchus basiri* Khan,1965
20	*D. bhatnagari*(Tikayani & Khera, 1969)Fortuner & Maggenti,1987	Zool.Anz.*(1969) 182:87-91*	*Nothotylenchus bhatnagari* Tikayani & Khera,1969.
21	*D. cylindricus* (Khan & Siddiqi,1968) Fortuner & Maggenti,1987	Nematologica *(1968)14:369-376*	*Nothotylenchus cylindricus* Khan & Siddiqi,1968; *N. elongatus* Hussain & Khan,1974;*D. elongates* (Hussain & Khan 1974) Fortuner & Maggenti,1987
22	*D.buckleyi* (Das,1960) Fortuner & Maggenti,1987	Z. ParasitKde *(1960) 19:553-605*	*Nothotylenchus buckleyi* Das,1960
23	*D. oryzae* (Mathur *et al*.1966) Fortuner & Maggenti,1987	Nematologica *(1966) 12:448-452*	*Basiroides oryzae* Mathur *et al*. 1966; *Paurodontus oryzae* (Mathur *et al*.,1966) Sumenkova,1975; *Nothotylenchus oryzae* (Mathur *et al*.,1966) Siddiqi,1986
24	*D. hexaglyphus* (Khan & Siddiqi, 1968) Fortuner & Maggenti,1987	Nematologica (*1968) 14: 369-376*	*Nothotylenchus hexaglyphus* Khan & Siddiqi,1968
25	*D. taylori* (Hussain & Khan, 1974)Fortuner & Maggenti,1987	Indian J. Nematol. *(1974) 4:81-87*	*Nothotylenchus taylori* Hussain & Khan,1974
26	*D. citri* (Varaprasad *et al.* 1980) Fortuner & Maggenti,1987	Indian J.Nematol *(1980) 10:182-188*	*Paurodontus citri* Varaprasad *et al.* 1980; *Nothotylenchus citri* (Varaprasad *et al*.,1980) Siddiqi,1986
27	*D. fotedari* Mahajan,1977)Fortuner & Maggenti,1987	Rev. Parassit *(1977) 38:334-337*	=*Nothotylenchus fotedari* Mahajan,1977
28	*D. phyllobius* (Thome,1934) Thorne,1936	Indian J.Nematol *(1982) 12:416-418*	*Anguillulina phyllobia* Thorne, 1934*; Nothanguina phyllobia* Thome, 1961; *Orrina phyllobia* (Thorne,1934) Brzeski,1981
29	*D. similis* (Siddiqi,1961)n.comb.	Proc. Helminth. Soc. Wash *(1961) 28:213-215*	*Parurodontus similis* Siddiqi,1961
30	*D.varaprasadi* Fortuner and Maggenti,1987	Indian J. Nematol *(1980) 10:182-188*	*Paurodontus solani* Varaprasad et.al,1981 ; *Nothotylenchus solani* (Varaprasad et.al.,1981) Siddiqi,1986 nec *Ditylenchus solani* Hussain and Khan,1976
31	*D. floricus*		--------
32	*D. robustus* Das and Bajaj, 2005	Indian J. Nematol *(2005)* 35 (1) : 11-35	---------
33	*D. triticus* Das and Bajaj, 2005	Indian J. Nematol *(2005)* 35 (1) : 11-35	--------
34	*Anguina tritici* (Steinbuch,1799) Filipjev,1936	CIH Description of Plant –parasitic Nematodes Set-1	*Vibrio tritici* Steinbuch ,1799; *Rhabditis tritici* (Steinbuch,1799) Dujardin,1845; *Anguillula tritici* (Steinbuch,1799) Gervais & Van Beneden,1859
35	*Subanguina chrysopogoni* Bajaj *et al*.,1990	Nematologica (1990) *36:55-72*	--------
36	*S. minuta* Bajaj,1995	Indian J. Nematol. *(1995)25:103-106*	---------
37	*S. neominuta* Das and Bajaj, 2004	Indian J. Nematol *(2004*) 34 (2): 153-159	---------
38	*Indoditylenchus Sundarnanensis* Sinha *et al*.,1985	Indian J. Helminth *(1985) 2 (ns) 31-35*	--------
39	*A. cecidoplastes* (Goodey,1934) Filipjev,1936	J. Helminth *(1934) 12:225-236*	*Anguillulina cecidoplastes* Goodey,1934; *Nothanguina cecidoplastes* (Goodey,1934) Withehead,1959
40	*D. bhatti* Das and Bajaj, 2005	Indian J. Nematol *(2005)* 35 (1) : 11-35	*Nothotylenchus bhatnagari* Tikayani & Khera,1969.

Forty species of Anguinidae belonging to four genera (*Anguina, Subanguina, Ditylenchus* and *Indoditylenchus*) have been reported from India. The recorded species of Anguinids from India are : *Ditylenchus acuminatus, D. anchilisposomus, D. angustus,D. ausafi, D. brassicae, D. cyperi, D. emus, D. solani, D. indicus, D. khani, D. medicaginis, D. myceliophagus, D. mirus, D. nanus, D. trifomis*, *D. hisarensis, D. zeae , D. acutus, D. basiri, D. bhatnagari, D. cylindricus, D. buckleyi, D. oryzeae, D. hexaglyphus, D. taylori, D. citri, D. fotedari, D. phyllobius, D. similes, D. varaprasadi, D. floricus , D. robustus , D. triticus, D. bhattii, Anguina tritici, A. cecidoplastes, Sunanguina chrysopogoni, S. minuta, S. neominuta, Indoditylenchus sundarbanensis.* In an attempt was made to review the Indian species of Anguinids and to prepare an effective check list for their easy identification.

Table 3 Host, locality and habitat of Indian species of Anguinids

Sl No	Species name	Host	Locality	Habitat
1	*D. acuminatus*	Citrus sp	Panipat, India	Rhizosphere
2	*D. anchillisposomus*	Grass	Univ,California ,U.S.A	Rhizosphere
3	*D. angustus*	Oryza sativa	Nowakhali, Bangladesh	Aerial plant parts
4	*D.ausafi*	Rosa sp.	Aligarh, India	Rhizosphere
5	*D. brassicae*	Brassica oleracea	Ranikhet, India	Rhizosphere
6	*D. cyperi*	Cyperus rotundus	Aligarh, India	Rhizosphere
7	*D. emus*	Mangifera indica	New Delhi, India	Rhizosphere
8	*D. solani*	Solanum tuberrosum	Hapur, India	Rhizosphere
9	*D. indicus*	Hordeum vulgare	Babhrai, India	Rhizosphere
10	*D. khani*	Vitis vinifera	New Delhi, India	Rhizosphere
11	*D. medicaginis*	Soil	Poland	Rhizosphere
12	*D. myceliophagus*	Agaricus bisporus	Eari Shilton, England	Rhizosphere
13	*D.mirus*	Zea mays	Jamalpur, India	Rhizosphere
14	*D.nanus*	Psidium guajava	Jamalpur, India	Rhizosphere
15	*D. triformis*	Gladiolus sp.	Wilmington, USA	Rhizosphere
16	*D. hisarensis*	Zea mays	Hisar, India	Rhizosphere
17	*D. zeae*	Zea mays	Ambala, India	Rhizosphere
18	*D. acutus*	Plumeria actifolia	Shahjahanpur, India	Rhizosphere
19	*D. basiri*	Mangifera indica	Shahjahanpur, India	Rhizosphere
20	*D. bhatnagari*	Sorghum vulgare	Jodhpur, India	Rhizosphere
21	*D. cylindricus*	Brassica oleracea	Ranikhet, India	Rhizosphere
22	*D. buckleyi*	Cucurbita maxima	Hyderabad, India	Rhizosphere
23	*D. oryzea*	Oryza sativa	Bikramganj, India	Rhizosphere
24	*D. hexaglyphus*	Solanum tuberosum	Ranikhet, India	Rhizosphere
25	*D. taylori*	Solanum tuberosum	Aligarh, India	Rhizosphere
26	*D. citri*	Citrus sp.	Delhi, India	Rhizosphere
27	*D. fotedari*	Fallow soil	Delhi, India	Rhizosphere
28	*D. phyllobius*	Solanum elaeagnifolium	Coimbatore, India	Leaf gall
29	*D. similes*	Brassica oleracea	Aligarh, India	Rhizosphere
30	*D. varaprasadi*	Solanum melongena	Delhi, India	Rhizosphere
31	*D. floricus*	Chrysopogon fulvus	Morni Hills, India	Inflorescence
32	*D. robustus*	Sorghum bicolor	Hisar, India	Rhizosphere
33	*D. triticus*	Triticum aestivum	Swarupgarh, India	Rhizosphere
34	*A. tritici*	Triticum aestivum	England	Seed gall
35	*S. chrysopogoni*	Chrysopogon fulvus	Ambala, India	Seed gall
36	*S. minuta*	Unidentified grass	Hisar, India	Root gall (?)
37	*S. neominuta*	Unidentified grass	Panchkula, India	Root gall (?)
38	*I. sundarbanensis*	Avicennia offcinalis	Prentice Island, India	Rhizosphere
39	*A. cecidoplastes*	Bothriochloa pertusa	Andhra Pradesh, India	Leaf, stem, floral gall
40	*D. bhattii*	Cynodon dactylon	Hisar, India	Rhizosphere

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