

A review of Neotylenchoidea Thorne, 1941 (Nemata : Tylenchida)

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SUMMARY

The taxonomic status of families and genera in Neotylenchoidea (*sensu* Jairajpuri & Siddiqi, 1969) is commented. The suborder Hexatyliina is accepted with Neotylenchidae as the only family and *Hexatylus* as the only genus, *Deladenus*, *Gymnotylenchus*, and *Dorsalla* are accepted in Allantonematoidea. Halenchinae, Paurodontidae, Misticiinae, and Gymnotylenchidae are rejected. *Stictylus* is considered *incertae sedis* in Tylenchida. *Paurodontus* and *Misticus* are considered *incertae sedis* in Tylenchoidea. *Neopaurodontus*, *Anguillonema*, *Sakia*, *Basiliophora* and *Neomisticus* are considered *genera dubia*. *Paurodontella* is proposed as a new synonym of *Paurodontus* and *Dotylaphus* as a new synonym of *Deladenus*. The synonymy of *Paurodontoides* and *Bealius* with *Stictylus* is accepted. *Neopaurodontus asymmetricus*, *Anguillonema polygraphi*, *A. crenati*, *A. rhizomorphoides*, *Sakia typica*, *Basiliophora castori*, *B. indica*, *B. jonesi*, and *B. propora* are considered *species inquirendae*.

RÉSUMÉ

Révision des Neotylenchoidea Thorne, 1941 (Nemata : Tylenchida)

Le statut taxinomique des familles et des genres de Neotylenchoidea (*sensu* Jairajpuri & Siddiqi, 1969) est commenté. Le sous-ordre des Hexatyliina est accepté avec les Neotylenchidae comme seule famille et *Hexatylus* comme seul genre. *Deladenus*, *Gymnotylenchus* et *Dorsalla* sont acceptés dans les Allantonematoidea. Les familles Paurodontidae, Misticiinae et Gymnotylenchidae sont rejetées. *Stictylus* est considéré comme *genus incertae sedis* dans les Tylenchida. *Paurodontus* et *Misticus* sont considérés comme *genera incertae sedis* dans les Tylenchoidea. *Neopaurodontus*, *Anguillonema*, *Sakia*, *Basiliophora* et *Neomisticus* sont considérés comme *genera dubia*. *Paurodontella* est proposé comme synonyme mineur de *Paurodontus* et *Dotylaphus* comme synonyme mineur de *Deladenus*. Les synonymisations de *Paurodontoides* et de *Bealius* avec *Stictylus* sont acceptées. *Neopaurodontus asymmetricus*, *Anguillonema polygraphi*, *A. crenati*, *A. rhizomorphoides*, *Sakia typica*, *Basiliophora castori*, *B. indica*, *B. jonesi*, et *B. propora* sont considérés comme *species inquirendae*.

In 1941, Thorne grouped "some nematodes of the family Tylenchidae which do not possess a valvular median esophageal bulb" into three new subfamilies: Neotylenchinae, Paurodontinae, and Nothotylenchinae. He predicted that the first two subfamilies will eventually be raised to family rank because they can be distinguished from all other tylenchs. In 1949, Thorne included all three subfamilies into Neotylenchidae n. grad., that he defined primarily because of the absence of valvular median esophageal bulbs. He was aware of the heterogeneity of the family and hoped that future workers would arrange the many divergent forms into their respective groups.

In spite of this, Neotylenchidae continued for many years to be the dumping ground — the catch-all said Thorne (1949) — for unrelated forms that were assembled together only because they lacked one structure, the

valvular median bulb. New genera and new subfamilies were proposed in this taxon by various authors until Jairajpuri and Siddiqi (1969) raised it to superfamily level. According to these authors, Neotylenchoidea included at the time: Neotylenchidae, Paurodontidae (with Misticiinae), Nothotylenchidae (with Boleodorinae and Halenchinae), Ecphyadophoridae, and Sphaerulariidae (with Allantonematiniae, Fergusobiinae, and Ionchiinae).

At the same time, E. Khan (1969) considered that the absence of valves in the median bulb can be used only at subfamily rank. He rearranged the Neotylenchidae based on number of sectors in the head. Neotylenchidae would be comprised of only two subfamilies (Neotylenchinae and Deladeninae) having heads with eight sectors; Nothotylenchinae and Halenchinae with six head sectors would be transferred to Tylenchidae.

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Paramonov (1970) considered Neotylenchidae (renamed Hexatyliidae by this author in defiance to the Code of Nomenclature) to be monophyletic, but he moved *Nothanguina* to Anguininae. Geraert (1971) recognized the similarity of *Boleodorus* with the genera in Psilenchinae, and he transferred the subfamily Boleodorinae to Tylenchidae. Husain (1972) argued to retain Neotylenchidae and proposed the subfamilies transferred by Khan (1969) to Tylenchidae be returned to Neotylenchidae. Husain cited *Paurodontoidea* as one genus with eight head sectors in Paurodontinae where the remaining genera have six sectors. He rejected the elevation of Neotylenchidae to superfamily rank because "... in all the neotylenchs the type of oesophagus is a minor variant of the typical tylenchoid type". Husain did not diagnose Neotylenchidae as he conceived it in light of the above. Sumenkova (1974) also was of the opinion that the genera in Nothotylenchidae (*Nothotylenchus*, *Thada*, *Sakia*, *Dorsalla*, and *Boleodorus*) have a typical tylenchoid esophagus with corpus, isthmus, and "cardial section". She, consequently, transferred this subfamily to Tylenchidae. She kept in Neotylenchoidea only the taxa (Sphaerulariidae, Paurodontidae, Misticiinae, and Neotylenchidae) with a different esophagus where the corpus has no median bulb, no myofibrils, cuticular lining is not expressed, and where the isthmus and the "cardial part" of the esophagus are practically absent. The intestine joins with the esophagus at the posterior end of the corpus, and the esophageal glands are arranged as a long lobe lying over the intestine.

Shepherd and Clark (1976) proved, by a detailed study with transmission electron microscope, the reality of this description in *Hexatylus viviparus*.

Parallel to this reevaluation of the structure of the esophagus, Bedding (1967, 1968) proved that the neotylenchid genus *Deladenus* is, in fact, the free-form of an insect parasit that resembles the forms in Allantonematidae.

Siddiqi (1979) rejected the absence of valvulate median bulb, even as a subfamily character, and proposed the new valveless genus *Duosulcius* in Tylenchidae. His new subfamily Duosulciinae includes some genera with valves (*Malenchus*, *Miculenchus*, *Ottolenchus*), *Deladenus*, *Gymnotylenchus*, and *Dorsalla* in Neo-*Neomalenchus* with nonmuscular, nonvalvate median esophageal bulb.

In 1980, Siddiqi retained only *Hexatylus* (= *Neotylenchus*) *Deladenus*, *Gymnotylenchus*, and *Dorsalla* in Neotylenchoidea. He included this superfamily with Allantonematoidea and Sphaerularoidea in a new suborder, Hexatyliina. He placed all other historical neotylenchid families and genera in Tylenchina. The same author later added the superfamily Anguinoidea to Hexatyliina. He reduced Allantonematoidea to family level while raising Iotonchiidae to superfamily; all in Hexatyliina (Siddiqi, 1986).

Geraert and Raski (1987) with Tylenchidae, and

Fortuner and Maggenti (1987) with Anguinidae considered that absence of valves was not in itself a differentiating character even at generic level. They synonymized, for example, *Lambertia* with *Tylenchus* (Geraert & Raski, 1987) and *Nothotylenchus* with *Ditylenchus* (Fortuner & Maggenti, 1987). Even after the actions of these authors, the taxonomic position of some genera remains unsettled.

With the rejection of absence of median bulb valve as family criteria, an emended diagnosis of Neotylenchidae needs to be proposed. The status of all the genera that were at one time or the other part of this family needs to be examined to decide which, if any, are left in it. An account for the current status of all the genera that have been removed from Neotylenchidae must be given. At the end of the article, Table 1 recapitulates all historical neotylenchids and gives their current status.

NEOTYLENCHIDAE Thorne, 1941 (Hexatyliinae in Paramonov (1970) is not available.)

DIAGNOSIS

Hexatyliina. Isthmus absent. Nerve ring encircling anterior intestine. Labial framework twelve-sectored. Oviduct with two discs of four cells. Organized spermatheca absent.

TYPE AND ONLY GENUS

Hexatylus Goodey, 1926

Hexatylus Goodey, 1926
= *Neotylenchus* Steiner, 1931
= *Scytaleum* Andr ssy, 1961

DESCRIPTION

Female : In face view, the basic six-sectored tylenchid pattern is modified by the insertion of stylet muscles that forms additional dorso-ventral and lateral ridges (Shepherd, Clark & Hooper, 1984.) Labial framework modified into a twelve-sectored structure by bifurcation of each branch of the basic six-sector framework to accommodate the passage of stylet muscles. Stylet protractor muscles attached to labial framework and to cuticle of the front of the body (Shepherd, Clark & Hooper 1984). Stylet with three bifurcate knobs.

Esophagus with cylindroid corpus without median bulb. Corpus lumen oval in cross section. Esophageal glands a long lobe overlapping the intestine. The gland outlets empty in the corpus. Isthmus absent. Esophago-intestinal junction in the corpus, consisting of two small extensions from two esophageal cells. Anterior intestine with narrow tubular lumen. Nerve ring encircling the anterior intestine (Shepherd & Clark, 1976).

One anterior genital branch. No post-uterine sac. Ovary elongate with oocytes in multiple rows in the

cells arranged as two discs of four cells. Uterus elongate not differentiated in spermatheca and columned uterus but appears as a single structure with 28-32 cells arranged in four columns. (Geraert, 1976). Female tail conoid.

Female tail conoid.

Male : unknown.

BIOLOGY

Mycetophagous.

TYPE SPECIES

Hexatyclus viviparus Goodey, 1926.

OTHER SPECIES

See list in Siddiqi (1986).

COMMENTS

Hexatyclus differs markedly from Tylenchina by the structure of the esophagus (complete absence of isthmus, nerve ring encircling the anterior intestine). The twelve-sectored labial framework also seems to be unique.

This genus also differs from both Tylenchina and the sphaerularid-allantonematid complex by the structure of the oviduct (two discs of four cells instead of fourteen cells in two rows of seven cells), and by the absence of organized spermatheca.

Geraert's (1976) opinion was that *Hexatyclus* might represent a separate suborder. Siddiqi (1980) proposed Hexatylyna, new suborder, but included in it also the superfamilies Sphaerularoidea and Allantonematoidea.

It is not known whether *Deladenus* and other allantonematids have circumintestinal nerve ring, twelve-sectored framework, and oval esophageal lumen similar to *Hexatyclus*. If they do, it will become justified to group *Hexatyclus* and the sphaerularid-allantonematid into the same suborder (Hexatylyna). *Hexatyclus* because of its distinctive oviduct, would be the type and sole representative of the family Neotylenchidae in this suborder.

Until the structure of the above-mentioned morphological features are studied in detail (preferably with transmission electron microscope) in *Deladenus* and other allantonematids, it seems best to consider *Hexatyclus* as different enough from the sphaerularid-allantonematids to be placed in a suborder of its own, Hexatylyna, with one monotypic family : Neotylenchidae.

In 1986, Siddiqi added Anguinoidea to the sub-order Hexatylyna. Anguinids differ from the forms in Hexatylyna by being plant-parasitic or mycetophagous, rarely insect-associates (*Sychnotylenchus*), never entomoparasitic; by having simple life-cycle; by having nerve ring encircling isthmus, never circumintestinal; and by not absorbing food from body surface. Anguinids are closer

from tylenchids to the extent that some *Ditylenchus* spp. can mistakenly be placed in Tylenchidae. Anguinidae is here considered as a family under Tylenchoidea (Fortuner & Maggenti, 1987).

Status of genera traditionally accepted in Neotylenchidae

Deladenus Thorne, 1941

= *Dotylaphus* Andr ssy, 1958 (n. syn.)

= *Hadrodenus* Mulvey, 1969

DESCRIPTION

Mycetophagous females : Stylet small, with knobs, cone very thin without visible lumen. Corpus not differentiated into median bulb, but with median chamber. Nerve ring probably encircling isthmus. Dorsal gland opening close to base of stylet, subventral gland ducts open into median chamber. Dorsal gland elongated, lying over beginning of intestine; only trace of subventral glands apparent. Intestine functional, with wide lumen, joining esophagus at base of thin isthmus.

One anterior genital branch. Ovary with long multiplication area, then oocytes in one/two rows. Oviduct with fourteen cells in two rows of seven cells. Spermatheca elongated, filled with large sperms, in line with genital tract, apparently with four to six sets of six cells. Columned uterus with four rows of four cells. Few-celled valve present at beginning of uterine sac. No posterior genital branch; post-uterine sac generally absent.

Parasitic females : Stylet long, stout, knobless, not differentiated into cone and shaft, with wide lumen. Corpus cylindrical, with median chamber. Dorsal gland opening about one stylet length from stylet base. Dorsal gland within esophagus. Subventral gland well developed, with two or three lobes. Intestine with no visible lumen, probably degenerate. Ovary short. Oviduct as in mycetophagous female. Spermatheca short, empty, with three sets of four cells. Uterus elongated, filled with small sperms.

Males : Similar to mycetophagous females. Caudal alae enveloping tail. Spicules and gubernaculum tylenchoid. Sperm cells of two types : *i*) large (about 10 μ m) amoeboid spermatozoa found in mycetophagous females; *ii*) small (about 1-2 μ m) spermatozoa composed mostly of nucleus, found in parasitic females.

TYPE SPECIES

Deladenus durus (Cobb, 1922) Thorne, 1941

OTHER SPECIES

D. andrassyi Vinciguerra, 1972

- D. arboricolus* (Cobb, 1922) Goodey & Franklin in Goodey, 1956
D. aridus Andrassy, 1957
D. canii Bedding, 1974
D. imperialis Bedding, 1974
D. indicus Singh, 1976
D. ipini Massey, 1974
D. lonchites (Massey, 1974) n. comb.
 = *Dotylaphus lonchites* Massey, 1974
D. megacondylus (Mulvey, 1969) Sumenkova, 1975
 = *Hadrodenus megacondylus* Mulvey, 1969
D. nevexii Bedding, 1974
D. norimbergensis Rühm, 1956
D. obesus Thorne, 1941
D. paradurus Massey, 1974
D. proximus Bedding, 1974
D. rudyi Bedding, 1974
D. ruehmi (Andrassy, 1958) n. comb.
 = *Dotylaphus ruehmi* Andrassy, 1958
D. saccatus Andrassy, 1954
 = *Hadrodenus saccatus* (Andrassy, 1954) Mulvey, 1969
D. siridicicola Bedding, 1968
D. ulani Sultanalieva, 1983
D. wilsoni Bedding, 1968

COMMENTS

Bedding (1967, 1968) proved that *Deladenus* has a two-cycle life history. The first cycle is an amphimictic free-living cycle represented by fungus-feeding forms with the characteristics of the traditional description of *Deladenus*. The second is an insect-parasite cycle, represented by nematodes that are typical allantonematids. This description has been accepted by subsequent authors (Geraert, 1976; Siddiqi, 1980), but *Deladenus* has been retained until now in the family Neotylenchidae.

Deladenus should not be placed in the same family as *Hexatylys* because of the basic difference in the structure of the oviduct (Geraert, 1976). Because *Deladenus* has one of the forms in its two-cycle life history that corresponds to that description of allantonematids, this genus is here transferred to the family Allantonematidae Pereira in Chitwood & Chitwood, 1937*.

Because *Hexatylyna* Siddiqi, 1980, is proposed in this article as a suborder with only one genus, *Hexatylys*, the family Allantonematidae is here accepted under the suborder Sphaerulariina Maggenti, 1981.

Dotylaphus includes only one species, *D. ruehmi* Andrassy, 1958 described from a single female specimen. Its long knobless stylet with wide lumen and without visible separation between cone and shaft is similar to

that of parasitic females of *Deladenus*. Esophagus and gonads have not been described in as much detail as *Deladenus*, but no basic difference was observed between the two genera. Andrassy (1958), assumed that the specimen he found was a free-living form because he found it on moss but, in fact, it resembles parasitic females of *Deladenus*.

It seems best to consider *Dotylaphus* as junior synonym of *Deladenus*.

Hadrodenus with *H. megacondylus* (type species) and *H. saccatus* was said to differ from *Deladenus* by the more anterior position of vulva (77-79 % vs more than 90 %) and in the presence of post-uterine sac (absent in *Deladenus*). The validity of these two criteria is questionable for generic differentiation. The conclusion of Sumenkova (1975) who proposed *Hadrodenus* as a junior synonym of *Deladenus*, is accepted here.

Dorsalla Jairajpuri, 1966

This genus created for *D. indicus* (Jairajpuri, 1962) Jairajpuri, 1966 with body dorsally curved and deeply cleft vulva was placed in the family Contortylenchidae, Allantonematoidea by Siddiqi (1980). The same author later synonymized *Dorsalla* with *Fergusobia* in Neotylenchidae. All these forms, including *Dorsalla*, seem to belong in Sphaerulariina.

GYMNOTYLENCHIDAE Siddiqi, 1980

Gymnotylenchus Siddiqi, 1961

This genus, proposed for *G. zaeae*, has esophageal region similar to that of mycetophagous females of *Deladenus*. Differences in tail shape (longer and thinner in *Gymnotylenchus*), position of vulva (80-85 % in *Gymnotylenchus* vs over 90 %), and length of vulval slit (smaller in *Gymnotylenchus*), are not diagnostic at generic level. Males of *Gymnotylenchus* differ from males of *Deladenus* in absence of caudal alae and gubernaculum. Such criteria have been accepted at generic level in other families (*Miculylenchus* and *Polenichus* in Tylenchidae).

Gymnotylenchus is here accepted as a valid genus related to *Deladenus* in Allantonematoidea. The family Gymnotylenchidae is rejected.

HALENCHINAE Jairajpuri & Siddiqi, 1969

This subfamily has been rejected and its type and only genus, *Halenchus* Cobb, 1933 has been transferred to Anguinidae by Fortuner and Maggenti (1987).

* The Allantonematidae were proposed as a subfamily by Pereira (1932) in a thesis. The name was not available (Art. 8, 9, International Code of Zoological Nomenclature) until Pereira's proposal was included in a book by Chitwood and Chitwood (1937).

PAURODONTIDAE Thorne, 1941

REJECTION OF THE FAMILY

This taxon was proposed as a subfamily by Thorne (1941) because of the presence of a stem-like extension at the base of the esophagus. This stem seems to be caused by the intestine that overlaps the posterior end of the esophageal glands. To accommodate the overlapping intestine, the end of the glands is more slender than the rest of the organ and form the characteristic stem. This structure can easily be differentiated from a glandular overlap because the lumen of the esophagus runs through it.

Siddiqi (1980) considered Paurodontinae as a subfamily in Tylenchoidea. An esophageal stem has been described in *Cynipanguina* a genus proposed by its authors in Anguinidae because of the presence of a valvate median bulb (Maggenti, Hart & Paxman, 1974). Some paurodontids such as *Misticus* have been described "without a valvular apparatus, but a thickening of the lumen walls [is present in the median bulb]". It is not clear what is the difference between valves and thickenings in the median bulb. It is certain that the diagnosis of Paurodontidae (Tylenchina without valvate median bulb and with stem extension of the esophageal glands) can no longer be accepted. This family is rejected and its genera have to be assigned elsewhere.

***Paurodontus* Thorne, 1941**

= *Paurodontella* Husain & Khan, 1968 (n. syn.)

DESCRIPTION

Corpus with or without distinct median bulb; valve absent; isthmus present; esophageal glands with stem overlapped by anterior intestine. Length of stem variable. A "chamber" described surrounding the esophageal glands in some species (*P. gracilis*, *P. saxeni*, *P. solani*, *P. citri*, *P. bajrai*) is probably a fixation artifact.

Female genital system with one anterior branch, with or without a PUS. In a few species (*P. aberrans*, *P. apiticus*) there is a short offset branch at the anterior end of the oviduct. The structure and functions of this organ are not known. The details of the genital system, particularly the structure of spermatheca and columned uterus, are not clear.

Males with leptoderan caudal alae, short adanal or longer, reaching down to three fourths of the tail in *P. citri*. Structure of sperm cells unknown.

TYPE SPECIES

P. gracilis Thorne, 1941

OTHER SPECIES

P. aberrans Nandakumar & Khera, 1969

P. apiticus Thorne, 1941

= *Paurodontella apitica* (Thorne, 1941) Husain & Khan, 1968

P. auriculatus (Anderson, 1985) n. comb.

= *Paurodontella auriculata* Anderson, 1985

P. bajrai Khan, Mathur, Nand & Prasad, 1968

P. brassicae Das & Shivaswamy, 1980

P. chowdhuri Husain & Khan, 1965

P. citri Varaprasad, Khan & Lal, 1981

P. consobrinus (de Man, 1907) Nickle, 1968

P. densus Thorne, 1941

= *Paurodontella densa* (Thorne, 1941) Husain & Khan, 1968

P. indicus Nanjappa & Khan, 1970

P. minutus (Husain & Khan, 1968) n. comb.

= *Paurodontella minuta* Husain & Khan, 1968

P. neosimilis Khan & Basir, 1964

P. niger Thorne, 1941

= *Paurodontella nigra* (Thorne, 1941) Husain & Khan, 1968

P. saxeni Husain & Khan, 1965

P. similis Siddiqi, 1961

P. sohailai (Maqbool, 1982) n. comb.

= *Paurodontella sohailai* Maqbool, 1982

P. solani Varaprasad, Khan & Lal, 1981

DISCUSSION

Paurodontella was differentiated from *Paurodontus* by Husain and Khan (1968) by "robust" body, short convex-conoid tail, and long stem. These authors redefined *Paurodontus* with slender body, long filiform tail, and short stem.

We have to assume that the terms "robust." and "slender" for the body, and "short" and "long filiform" for the tail refer, in fact, to the ratios *a* and *c'* respectively. *Paurodontella* do have a body a little more "robust" (*a* = 17 to 25 vs 30 to 45 in *Paurodontus*) and a slightly shorter tail (*c'* = 3 to 4.5 vs 3 to 7 in *Paurodontus*). There is no difference in tail shape between the two genera.

The stem length is not given in any specific description in both genera. From figures, it seems to vary from 6 to 17 μm in *Paurodontella*. In *Paurodontus* it varies from very short or almost absent (*P. saxeni*, *P. chowdhuri*, *P. solani*, *P. bajrai*) to about 8 to 15 μm (*P. similis*, *P. citri*).

The caudal alae are given as "ditylenchoid" in *Paurodontella* and as "adanal tylenchoid" in *Paurodontus* by Husain and Khan (1968). The caudal alae of *Paurodontella minuta* are short, reaching down the tail for 1 to 1.5 body diameters. Alae in *Paurodontus* vary from short (reaching down for one body diameter in *P. gracilis*) to very long (reaching down to three-fourths of the tail in *P. citri*). The diagnosis of *Paurodontella* was recently emended by Anderson (1985) who found only differences in measurements (PUS length, ratio *a*, and

vulva-anus distance) between this genus and *Paurodontus*.

In conclusion, the slight differences noted between the species in *Paurodontus* and *Paurodontella* are not accepted as diagnostic at generic level. *Paurodontella* is here proposed as a junior synonym of *Paurodontus*.

Siddiqi (1986) hypothesizes that *Paurodontus* spp. may have an insect-parasitic cycle because he found a species similar to *Paurodontus* with sphaerularoid pre-parasitic females. He placed Paurodontidae in Sphaerularioidea. Until the existence of a sphaerularid life-cycle is demonstrated more conclusively for the species in *Paurodontus*, this genus is best kept in Tylenchoidea because of the structure of the esophagus with isthmus present. Detailed study of the genital system is needed before this genus can be placed in a particular family in Tylenchoidea. For the moment, it is best to consider *Paurodontus* as *genus incertae sedis* in Tylenchoidea.

***Stictylus* Thorne, 1941**

- = *Paurodontoides* Jairajpuri & Siddiqi, 1969
- = *Bealius* Massey & Hinds, 1970

DESCRIPTION

Face view (SEM of *S. intermedius*) with six lip sectors. Lateral sectors smaller. Four submedian lobes with central longitudinal ridges. Eight-sectored lip region described for *Paurodontoides*, six equal lip sectors for *Bealius*, but no SEM photographs have yet been published for either genera (Geraert, Raski & Choi, 1985).

Stylet small with asymmetrical knobs. Corpus without median bulb or with slight swelling. Valves absent. Isthmus present. Esophageal glands with or without stem (Geraert, Raski & Choi, 1985).

One anterior genital branch, no posterior branch; PUS present or absent. Ovary sometimes very long and flexed reaching into the esophageal region. Oviduct with two rows of cells. Oval to elongated spermatheca in line with genital track, packed with small sperms (1.5 to 2 µm in diameter in *S. intermedius*). Long columned uterus. Vagina obliquely forwards. Vulva between bulges of the body, epiptygma present (Geraert, Raski & Choi, 1985).

Female tail cylindrical with rounded end, length variable (tail conoid in *Paurodontoides*). Phasmid not seen.

Male with conical tail enveloped by caudal alae. Spicules short and wide, gubernaculum simple.

TYPE SPECIES

- S. asymmetricus* Thorne, 1941

OTHER SPECIES

- S. annamari* (Massey, 1974) Geraert, Raski & Choi, 1985

- S. bisulcus* (Massey & Hinds, 1970) Sumenkova, 1975
- S. intermedius* (Christie, 1938) Geraert, Raski & Choi, 1985
- S. leperisini* (Massey, 1974) Geraert, Raski & Choi, 1985
- S. linfordi* (Hechler, 1962) Sumenkova, 1975
- S. macrocellus* Anderson & Das, 1967
- S. mucronatus* Thorne & Malek, 1968
- S. mycophilus* Rühm, 1956
- S. obtusus* Thorne, 1941
- S. pinguicauda* (Fuchs, 1938) Geraert, Raski & Choi, 1985
- S. pissodi* (Massey & Hinds, 1970) Geraert, Raski & Choi, 1985
- S. pseudobtusus* Rühm, 1956
- S. stammeri* (Wachek, 1955) Rühm, 1956

Neotylenchus latus Thorne, 1935, placed in *Paurodontoides* by Siddiqi (1986) is a *species inquirenda*.

DISCUSSION

The genera *Stictylus*, *Paurodontoides*, and *Bealius* are remarkably similar. The first two have been considered as synonyms by Andrassy (1976). *Bealius* has been proposed as synonym of *Stictylus* by Sumenkova (1975) and Geraert, Raski and Choi (1985).

Paurodontoides was said to differ from *Stictylus* by an eight-sectored lip region. No SEM photograph exists of *P. linfordi*, the type and only species of this genus. The recent study of Shepherd and Clark (1984) on *Hexatylus viviparus* proved the difficulty to interpret face view from light microscope observations. For the moment, it seems best to consider *Paurodontoides* as synonym to *Stictylus*.

Geraert, Raski and Choi (1985) showed that the characters differentiating *Bealius* from *Stictylus* (absence of lateral field, presence of six equal-sized lip sectors, overlap of anterior vulval lip, and bifid spicule) have no generic diagnostic value. This synonymization was rejected by Siddiqi (1986) with no new argument or justification.

Stictylus has a lip region somewhat reminiscent of *Hexatylus* (ridges), but its esophagus is definitely of the Tylenchina kind (isthmus present, encircled by nerve ring). Its genital system resembles the anguinid-type (long-flexed ovary, long columned uterus), but the small spermatheca points more towards the tylenchids. The oviduct is of the Tylenchina kind and different from the two four-celled oviduct of *Hexatylus*. Rühm (1956) considered some *Stictylus* species to be the free-living stage of some insect-parasite *Sphaerularia* or *Sphaerulariopsis* (*Sphaerulariina*). He synonymized *Sphaerulariopsis* Wachek, 1955, with *Stictylus*. Nickle (1963) considered the gonad of *S. asymmetricus* not to be of the allantonematoid-type. *Stictylus* genital system was later said to resemble that structure in *Deladenus*, a genus

now in Allantonematidae, Sphaerulariina (Geraert, Raski & Choi, 1985).

Siddiqi (1986) synonymized *Stictylus* with *Prothallonema* Christie, 1938 in Sphaerulariinae, because *Sphaerularia hastata* Khan, 1957 (= *Stictylus hastatus* (Khan) Khan, 1960) infective female and adult female with everted uterus resembles *Prothallonema*. According to the same author, *Hexatylus intermedius* Christie, 1938 (= *Stictylus intermedius* (Christie) Geraert, Raski & Choi, 1985) is synonym with *P. dubium*, type species of *Prothallonema*.

Siddiqi (1986) does not comment on the taxonomic position of *Stictylus asymmetricus* Thorne, 1941, type species of the genus, and he transfers this species to *Prothallonema* without argument or justification. For the moment it is best to consider *Stictylus*, and its type species *S. asymmetricus*, as distinct from *Prothallonema*.

It is evident that a detailed study of the morphology and biology of the species in *Stictylus* is needed before this genus can be properly classified. For the moment, it is best to consider it as *genus incertae sedis* in Tylenchida.

Neopaurodonus Tikyani & Khera, 1968

This genus was proposed for *N. asymmetricus* Tikyani & Khera, 1968, with isthmus absent, esophageal glands asymmetrical with only two lobes — the largest one (dorsal lobe) ending in a stem.

N. asymmetricus was transferred to *Paurodontella* by Sumenkova (1975). This action made *Neopaurodonus* (published on June 10, 1968) a junior synonym of *Paurodontella* (published on March 1, 1968) as accepted by Siddiqi (1986). *Paurodontella* here is considered as a junior synonym of *Paurodonus* (above).

Neopaurodonus was given as a minor synonym of *Scytaleum* (= *Hexatylus*) by Andrassy (1976).

N. asymmetricus is poorly described and illustrated. It is best to consider it as *species inquirenda* and *Neopaurodonus* as *genus dubium*.

MISTICIINAE Massey, 1967

Misticus Massey, 1967

Misticiinae, and the genus *Misticus*, were proposed for *M. mustus*, with esophageal stem and with excretory pore far anterior, nearly at level of base of stylet. The stem is very long. *Misticus* was also said to be distinctive because of the location (subventral) of the esophago-intestinal junction. The fusiform median bulb is described without valve, but with a "thickening of the lumen wall". It is not clear how this structure differs

from a valve. Isthmus present, encircled by nerve ring.

One anterior genital branch and an elongated PUS. Ovary flexed in some specimens of *M. mustus*. Oviduct not described, illustrated as two rows of cells (Fig. 8 in Massey, 1967). Spermatheca as a small oval chamber in line with genital track and seemingly packed with small sperms. Columned uterus a long multi-celled structure (but Fig. 8 of Massey, 1967, shows a columned uterus different from Fig. 7 and text of same author). Vulva lips slightly protruding. Female tail conoid pointed. Phasmids at mid-tail.

Male with caudal alae reaching almost to the tail tip.

Misticus has many characters of the anguinids (genital system except spermatheca; anterior position of excretory pore as in *Sychnotylenchus*). The small oval spermatheca and the small sperm cells do not correspond to the family Anguinidae. For the moment *Misticus* is considered *genus incertae sedis* in Tylenchoidea. The subfamily Misticiinae cannot be accepted until the status of its type genus is settled.

Anguillonema Fuchs, 1938

This genus was poorly described by Fuchs (1938) and never correctly redescribed in spite of the works of Rühm (1956) and Massey (1974). Particularly the morphology of the esophageal glands is quite unclear. Golden (1971) and Andrassy (1976) placed this genus in Misticiinae (Paurodontidae), but the stem characteristic of these groups was never described in *Anguillonema*.

Of the original species of Fuchs (1938) and of the species later added to *Anguillonema* by Rühm (1956) and Massey (1974), only three [*A. polygraphi* (type), *A. crenati*, and *A. rhizomorphoides*] remain in the genus after the action of Geraert, Raski and Choi (1985).

A. rhizomorphoides Rühm, 1955, is very similar to *Sychnotylenchus* (anterior position of excretory pore, cylindroid female tail with rounded end, caudal alae enveloping male tail). The corpus of the esophagus is similar to *Stictylus*, but there is no stem at the posterior end of the glands.

Siddiqi (1986) made *A. rhizomorphoides* the type-species of a new genus, *Neomisticus*, in Paurodontinae. He describes the genus with "stem-like basal extension." The base of the esophagus of *A. rhizomorphoides* is not described in the original publication (Rühm, 1955). The original illustration (Fig. 2, b in Rühm, 1955) shows that the esophagus base is not ensheathed by the intestine. It is quite distinct from esophagus in *Paurodonus*.

The descriptions of *A. polygraphi* and *A. crenati* are very incomplete. It is not known whether an isthmus is present or not. These three species are considered *species inquirendae*. *Neomisticus* and *Anguillonema* are considered *genera dubia*.

NOTHOTYLENCHIDAE

Transfers to Anguinidae

Nothotylenchidae has been proposed as a synonym of Anguinidae, and *Nothotylenchus* as a synonym of *Ditylenchus*; *Thada* has been considered a valid genus in Anguinidae (Fortuner & Maggenti, 1987).

Transfers to Tylenchidae

Lambertia Brzeski, 1977 has been proposed as a minor synonym of *Tylenchus*; *Neothada* Khan, 1973 has been considered a valid genus in Tylenchidae; *Luella* Massey, 1974 has been proposed as a *genus incertae sedis*, also in Tylenchidae (Geraert & Raski, 1987).

Sakia Khan, 1964, and *Basiliophora* Husain & Khan, 1965

The genus *Sakia* was proposed for a new species, *Sakia typica*, by Khan (1964) as a monotypic genus belonging to the Neotylenchidae. The genus was described with morphological characters which apply to many different tylenchs: body slender, almost straight when killed; head flat, cap-like; labial framework hexaradiate; ovary single outstretched; cone 50 percent of total stylet length, knobs present; spermatheca not set-off; post-uterine sac present, reduced; tail of both sexes elongate, filiform; caudal alae adanal, spicules and gubernaculum tylenchoid.

Only one character was unusual: amphid apertures were described as "small, oval slits". This will be discussed later. The genus was judged to resemble *Boleodorus* Thorne, 1941, but distinguished by its flat cap-like head, spermatheca not set off and body not assuming a coiled form on death.

No description of the esophagus was given, but placement in Neotylenchidae by Khan implied a slender median bulb with no valvular apparatus.

Husain and Khan (1965) proposed *Basiliophora* based on two new species (*B. indica* and *B. jonesi*) also assigned to the Neotylenchidae. Both were described with head slightly elevated, rounded, not set off; males with short, adanal caudal alae; and *B. jonesi* with four lines in lateral field (not mentioned for *B. indica*). *B. indica* was differentiated from *Ecphyadophora* and *Nothotylenchus*; *B. jonesi* was differentiated from *B. indica*. Cephalic framework was given as hexagonal in the diagnosis of the genus but no illustrations or other evidence was given to support this.

Khan *et al.*, (1968) compared "material collected from their respective type localities" and concluded that *Basiliophora* was a junior synonym of *Sakia*. They described *S. castori* as a new species with the follow-

ing characteristics: head with six equal lips, truncated, continuous with body; sixteen labial papillae in two circlets; and amphids pore-like located in lateral lips; males not found.

There is some doubt as to head morphology. First, the illustrations in Figure 2 (A, B, E) in Khan *et al.* (1968) show the head conoid-rounded, bullet-shaped, not truncate but is indeed continuous. The *en face* view (Fig. 2F) shows no evidence of labial papillae and sixteen in two circlets on that small a head is doubtful as to resolution by light microscopy. Of more concern are the "pore-like" amphids — quite generally for many years the concept of tylenchid amphids was pore-like on the labial area. Our present knowledge indicates there are few if any pore-like amphids amongst tylenchs (*Ecphyadophora* is an exception with tiny ovate amphids). Detection of delineation of amphids by light microscopy is now known to be very difficult — SEM photography has revealed much more accurately the nature of these structures.

Husain and Khan (1968) described another new species as *Basiliophora propora*, unaware of the actions of Khan *et al.* (1968).

Suryawanshi (1971) accepted the synonymization of *Basiliophora* with *Sakia* and transferred *B. propora* to *Sakia* as *S. propora* (Husain & Khan, 1968) comb. n. He described *S. allii* as a new species distinguished by its anteriorly flattened lip region, short tail ($c = 4.0-4.6$), and posterior vulva ($V = 59-61$). No mention was made of the amphidial structure or shape.

Husain (1972) also rejected synonymy of *Basiliophora* with *Sakia*. He cited the oval, slit-like amphids of *Sakia* which is "a character of Boleodorinae" and "in *Basiliophora* the amphid apertures are pore-like". His conclusion was to propose *Sakia* be considered "as *genus inquirendum*" and *S. castori* transferred to *Basiliophora*. Husain justified his proposed action on *Sakia* because the description of *Sakia* was inadequate and not accompanied by illustrations.

Reviewing the above, one more problem remains. No type material of *S. typica* was designated; there are no type specimens available for further study. Description by Khan (1964) of amphids "oval, slit-like" is not adequate when studied only by light microscopy. In sum, there is insufficient knowledge to recognize this taxon or its relationships to other taxa. *Sakia* is considered here as *genus dubium*. *Sakia typica* Khan, 1964 is here designated a *species inquirenda*.

Basiliophora poses a similar problem. Husain and Khan (1965) diagnosed *B. indica*, *B. jonesi*, and *B. propora* as closely resembling *Ecphyadophora*, a genus in Tylenchidae with tiny pore-like amphids. It is quite unlikely such amphids can be detected and accurately described by light microscopy. Furthermore, characteristics of the stylet are not mentioned except for total length and presence of knobs. The illustrations are generally inadequate in details of the stylet.

Basiliphora castori, *B. indica*, *B. jonesi*, and *B. pro-pora* are consequently designated *species inquirendae*. Until the nature of the cephalic morphology of the species of *Basiliphora* is definitely established the genus is considered *genus dubium*.

BOLEODORINAE Khan, 1964

Boleodorus Thorne, 1941

Boleodorinae and *Boleodorus* have been transferred to Tylenchidae by Raski and Geraert (1987).

Boleodoroides Mathur, Khan, & Prasad, 1966

This genus has been synonymized with *Ditylenchus* by Fortuner and Maggenti (1987).

NOTHANGUININAE, ECPHYADOPHORIDAE

Nothanguina was transferred to Anguinidae by Paramonov (1970) and was synonymized to *Anguina* by Fortuner and Maggenti (1987).

Ecphyadophorinae (*Ecphyadophora*, *Ecphyadophoroides*, and *Epicharinema*) is a subfamily under Tylenchidae for Raski *et al.* (1980).

Table 1
Recapitulation of the current status of the taxa previously in Neotylenchidae

| Taxa | Status | Tylenchidae | Anguinidae | Tylenchoidea | Sphaerulariina | Hexatyline | Tylenchida |
|--------------------------|------------------|-------------|------------|--------------|----------------|------------|------------|
| NEOTYLENCHIDAE | valid | | | | | × | |
| <i>Hexatylys</i> | valid | | | | | × | |
| = <i>Neotylenchus</i> | syn. | | | | | | |
| = <i>Scytaleum</i> | syn. | | | | | | |
| <i>Deladenus</i> | valid | | | | × | | |
| = <i>Dotylaphus</i> | syn. | | | | | | |
| = <i>Hadrodemus</i> | syn. | | | | | | |
| <i>Dorsalla</i> | valid | | | | × | | |
| GYMNOTYLENCHINAE | rejected | | | | | | |
| <i>Gymnotylenchus</i> | valid | | | | × | | |
| HALENCHINAE | rejected | | | | | | |
| <i>Halenchus</i> | valid | | × | | | | |
| PAURODONTIDAE | rejected | | | | | | |
| <i>Paurodontus</i> | <i>inc. sed.</i> | | | × | | | |
| = <i>Paurodontella</i> | syn. | | | | | | |
| <i>Stictylus</i> | <i>inc. sed.</i> | | | | | | × |
| = <i>Paurodontoides</i> | syn. | | | | | | |
| = <i>Bealius</i> | syn. | | | | | | |
| <i>Neopaurodontus</i> | <i>dubium</i> | | | | | | |
| MISTICIINAE | rejected | | | | | | |
| <i>Misticius</i> | <i>inc. sed.</i> | | | × | | | |
| <i>Anguillonema</i> | <i>dubium</i> | | | | | | |
| <i>Neomisticius</i> | <i>dubium</i> | | | | | | |
| NOTHOTYLENCHIDAE | rejected | | | | | | |
| <i>Nothotylenchus</i> | syn. | | × | | | | |
| <i>Thada</i> | valid | | × | | | | |
| <i>Lambertia</i> | syn. | × | | | | | |
| <i>Neothada</i> | valid | × | | | | | |
| <i>Luella</i> | <i>inc. sed.</i> | × | | | | | |
| <i>Sakia</i> | <i>dubium</i> | | | | | | |
| <i>Basiliphora</i> | <i>dubium</i> | | | | | | |
| BOLEODORINAE | valid | × | | | | | |
| <i>Boleodorus</i> | valid | × | | | | | |
| <i>Boleodoroides</i> | syn. | | × | | | | |
| NOTHANGUININAE | rejected | | | | | | |
| <i>Nothanguina</i> | syn. | | × | | | | |
| ECPHYADOPHORIDAE | valid | × | | | | | |
| <i>Ecphyadophora</i> | valid | × | | | | | |
| <i>Ecphyadophoroides</i> | valid | × | | | | | |
| <i>Epicharinema</i> | valid | × | | | | | |

DISCUSSION

Table 1 gives a recapitulation of the status of the genera and family of the traditional Neotylenchidae. With the present article the family Neotylenchidae, that was proposed more than 40 years ago for the nematodes of Tylenchidae which do not possess a valvular median esophageal bulb, is maintained with an entirely different diagnosis (structure of the oviduct) to accommodate only *Hexatylus*. The rest of the taxa that were once part of Neotylenchidae have been redistributed into two different suborders. Some still need to be studied for a correct relocation into families and suborders.

It is sometimes said that it is best to describe a taxon as new, even if its validity is doubtful. Neotylenchidae is a perfect example of the fallacy of this opinion. Thorne (1941) proposed it even though the artificial character of the group was already evident. It remained for 40 years a convenient catch-all for unrelated forms. Because they were unrelated, except by the absence of a structure, the genera proposed in this group were easy to differentiate from each other, even with incomplete descriptions. There was no incentive for their authors to describe the new taxa in every detail, and many important features, particularly the esophagus and the genital system, all too often were poorly described. Because of these poor descriptions and because of the artificial character of the family, most taxonomists were discouraged to attempt to review the existing genera (notable exceptions include Geraert and colleagues, Shepherd and colleagues, and Paramonov and colleagues who brought some hard facts to the ocean of uncertainties).

The difference in structure of genital systems of *Tylenchus* and *Ditylenchus* was first described by Wu (1967). It is probable that if Neotylenchidae had been rejected at the time, the genital systems of *Paurodontus* spp., *Misticus*, and other such taxa would have been better described. It would have been possible today to place them into their respective families in Tylenchoidea.

It is hoped that the lesson learned with Neotylenchidae will not be lost and artificial groupings of taxa will not be knowingly attempted in the future. It is also hoped that the present review will trigger a renewed interest for the taxa discussed here and a correct and complete reevaluation of their taxonomic position eventually will be proposed.

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