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## Taxa status of some reported plant parasitic nematodes in Indonesia

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**Abstract.** Since 1885, plant parasitic nematodes have been reported in Indonesia, and somewhere recorded in older nomenclatures. Taxa status of the nematode should be re-evaluated, since classification of the nematode might be changed by the consensus of some taxonomist based on the newest nematode morphological and or molecular phylogenetic differences. The objective of this work is to clear the confused older nematode nomenclature through nomenclatorial observations from older and modern description literatures, and updated electronic data (CABI, EPPO). From nomenclatorial observation results, earlier period recorded *Heterodera sp.* on wild tamarind and silk tree, *Heterodera marioni* on *Coffea sp.* and quinine plant, *Heterodera radicola* on *Coffea sp.* and sweet potato are the presently genus *Meloidogyne sp.* and *Heterodera javanica* is the presently *Meloidogyne javanica*; *Tylenchus similison* black pepper and tea are the presently species of *Radopholus similis*; *Tylenchus coffeae* on silk tree and *Coffea sp.* and *Tylenchus pratensis* Filip on *Coffea sp.* are the same presently species Pra *Tylenchus coffeae*; while *Radopholus oryzae* on paddy, is the presently species *Hirschmanniella oryzae*; and ring nematode, *Macrophostonia ornata* on black pepper and *Criconemella ornata* on citrus, are the same presently species, *Mesocriconema ornata*; and *Criconemella sp.* on black pepper is presently *Mesocriconema sp.*

### 1. Introduction

Plant parasitic nematode is one of agricultural importance, affecting crop production and productivity. Since 1885, plant parasitic nematodes (PPN) have been reported in Indonesia, such as: root-knot nematode, cysts nematode, root-lesion nematode, burrowing nematode, rice root nematode, and ring nematode. Otherwise some of them were recorded in older nomenclatures and classification. Classification of the PPN might be changed by the consensus of some taxonomist based on the newest finding in morphological and or molecular phylogenetic differences of the nematode.

Identification of the nematodes sometimes is difficult because of their morphological similarities, especially in the earlier period. *Pratylenchidae*, in the past most specific differences can only be detected using high magnification [1]. Later, data on the molecular characterization of the ring nematodes (*Criconematidae*), is necessary in order to validate their taxonomic status and infer phylogenetic relationships among their species (*Criconemoids* and *Mesocriconema*) [2]. It would be inevitable that many species were described on diagnostically insufficient basis and that very soon many of these species were considered synonyms of the oldest species.



The objective of this work is to clear the confused older nematode nomenclature by nomenclatorial observation method, in order to obtain the right information of their epidemiology history, and to provide the right basic data for further research and Indonesian crop commodity importing countries that dealing with plant quarantine importance nematode species.

## 2. Materials and methods

Evaluation of the taxa status of some plant parasitic nematodes was mainly towards those were recorded in older nomenclature by nomenclatorial observation. The data were collected from older and modern description published records, and updated electronic data (CABI and EPPO data sheets). Those older species/ genus name mostly have been transferred several times to other group of species/ genus name or classification up to present position (preferred species/ genus scientific name). Otherwise the earlier recorded nematode species names were considered synonyms (other scientific names) of the present position species name [2]. Nomenclatorial observations were carried out through evaluation of the nematode species name synonymies.

Main literatures to be referred were (1) List of Diseases of Important Economic Crop Plants Already Reported in Indonesia, Triharso, J Kaselan and Christanti, 1975, Bulletin No.14, Gadjah Mada University Press, Yogyakarta, (2) Diagnostic Manual for Industrial Crop Disease in Indonesia, JICA-Balitro, 1993, Bogor, (3) Host Index of Plant Diseases in Indonesia, Semarang, 1992, Gajah Mada University Press, Yogyakarta, and (4) Pest of Crops in Indonesia, van der Laan, P.A., 1981, (5) Taxonomy, identification and principal species, DJ Hunt and ZA Handoo, 2009, in Root-knot nematodes (Eds. RN Perry, M Moens, and JL Starr), CABI Europe-UK, (6) Commonwealth Institute of Helminthology Descriptions of Plant-parasitic Nematodes Sets, CAB UK.

Updated data were obtained from electronic data, included: 1) CABI data sheets of nematode species, 2) CABI Invasive Species Compendium data sheets (<https://www.cabi.org/isc/datasheet/16034>), 3) EPPO Quarantine Pest (Data sheets on Quarantine Pests), provided by CABI and EPPO. CABI is the Centre for Agriculture and Bioscience International focusing primarily on agricultural and environmental issues in the developing world. EPPO is European and Mediterranean Plant Protection Organization, provide global database of all pest-specific information that has been produced or collected by EPPO. The Global Database contents are constantly being updated by the EPPO Secretariat (<https://gd.eppo.int>).

The data from recent research results of plant parasitic nematodes associated with the same crops were also considered to support the discussions and conclusions.

## 3. Results and discussions

Based on literature studies, there were eleven (11) nematode species that recorded in the earlier period, i.e. *Heterodera sp.*, *Heterodera marioni*, *Heteroderaradicicola*, *Heterodera javanica* from family Meloidogynidae; *Tylenchus similis*, *Tylenchus coffeae*, *Tylenchus pratensis* Filip, *Radopholusoryzae* form *Pratylenchidae*; and in the modern description period, i.e. *Criconemella sp.*, *Criconemella ornata*, and *Macrophostonia ornata* from *Criconematidae*; that have to be reevaluated their nomenclatorial status.

### 3.1. Nematoda: Meloidogynidae (root-knot nematode)

Four species of *Heterodera* were reported on some crops in Indonesia in the period 1885-1950: *Heterodera sp.* on wild/river tamarind and silk tree/ Chinese Albizia, *Heterodera marioni* on *Coffea sp.* and quinine plant [3, 4, 5], *Heterodera radiculicola* on *Coffea sp.* and sweet potato [4], and *Heterodera javanica* on sugarcane [6].

According to Jepson [7], *Heterodera sp.* was one of genus scientific name synonymized to genus of *Meloidogyne spp.* (root-knot nematodes) from Family *Meloidogynidae* Skarbilovich, 1959. Before Chitwood [8], several genus name given to root-knot nematodes were *Anguillula*, *Heterodera*, *Oxyuris*, and *Caconema* [7]. According to Whitehead [9], in that period, root-knot nematodes were recorded under several species name i.e. *Anguillulamarioni* (Cornu 1879), *Anguillula radiculicola*

(Greeff 1872), *Heterodera radicola* (Müller 1884), *Heterodera marioni* (Goodey 1932), and *Caconema* (Cobb 1924). Goodey [10] made *Heterodera (Caconema) radicola* (Greeff, 1872) Cobb, 1924 a synonym of *Heterodera marioni* (Cornu, 1879) Goodey, 1932. After Chitwood [8], “root-knot nematode” was separated from “cyst nematode”, and given scientific name was *Meloidogyne Goeldi*, 1887 [7].

Treub [6] briefly described a “root-knot” nematode on the roots of diseased sugarcane, from Buitenzorg (Bogor) Botanical Gardens, Java. He named it *Heterodera javanica* and distinguished it from *H. radicola* Müller, 1884 by a few measurements [9]. *Heterodera javanica* Treub 1885 that reported on sugarcane in Java in 1885 is synonymized with some present species included *Meloidogyne javanica* (Treub, 1885) Chitwood 1949 [11, 12].

In the recent research results based on modern description, *Meloidogyne spp.* were detected on some those same host plants i.e. on *Coffea sp.* (*Meloidogyne sp.*, *Meloidogyne incognita*), on quinine plant (*Meloidogyne sp.*), and on sweet potato (*M. incognita*, *M. javanica*); and on sugarcane (*M. javanica*) [13, 14, 15, 16, 17]. Even though, there were not any report of *Meloidogyne spp.* associated with silk tree and wild tamarind yet, there were not any report of presently species *Heterodera spp.* (cyst nematodes) associated with those host plants in recent research yet.

Otherwise, *Heterodera spp.* that were recorded on those plants aboved in the earlier period are presently the genus *Meloidogyne sp.* (root-knot nematode), and not the genus *Heterodera sp.* (cyst nematode); and *Heterodera javanica* that was recorded on sugarcane is species *M. javanica*.

### 3.2. Nematoda: Pratylenchidae (root-lesion, burrowing and rice root nematode)

At one time, *Tylenchus sp.* was the large genus constituting the root-lesion nematode [18], burrowing nematode and rice root nematode. Filipjev [19] established the genus *Pratylenchus* for some genus *Tylenchus* recorded until before the year 1934. In the present-day position, modern concept of the group placed the root-lesion nematode in the genus *Pratylenchus* Filipjev, 1936 [1]. Additional knowledge of the taxonomy of these common world-wide parasites is needed in order to facilitate studies of their biology and control [20]. Four species of *Pratylenchidae* were recorded in the period 1898-1933, i.e. *Tylenchus coffeae*, *Tylenchus pratensis* Filip, *Tylenchus similis* and *Radopholus oryzae* (**Table 1**).

3.2.1. *Tylenchus coffeae*. *Tylenchus coffeae* was recorded on silk tree and *Coffea sp.* in Java in 1933, and 1917 respectively [4, 5]. In Siddiqi [21], *Tylenchus coffeae* along with other synonyms that recorded earlier were synonymized to presently species *Pratylenchus coffeae* (**Table 1**). Otherwise, *Tylenchus coffeae* on silk tree and *Coffea sp.* recorded in the earlier period is presently species *Pratylenchus coffeae*.

3.2.2. *Tylenchus pratensis* Filip. There were three scientific names of *Tylenchus pratensis* in earlier period for presently species of *Pratylenchus sp.*, i.e.: 1) *Tylenchus pratensis* (de Man, 1880), 2) *Tylenchus pratensis apud Bovien*, 1927; Steiner, 1927; Steiner, 1932; and 3) *Tylenchus pratensis* (non de Man) Filipjev and Shuurmans Stekhoven, 1941.

*Tylenchus pratensis* de Man, 1880 is synonym for presently species *Pratylenchus pratensis* [22]. *Tylenchus pratensis apud Bovien*, 1927; Steiner, 1927; Steiner, 1932 is synonym for presently species *Pratylenchus penetrans* [23]. *Tylenchus pratensis* Filip on *Coffea sp.* was regarded as *Tylenchus pratensis* (non de Man) Filipjev and Shuurmans Stekhoven, 1941, which based on classification by Ryss [24], was synonymized with presently species *Pratylenchus coffeae* (**Table 1**). Loof [25] interpreted that root-lesion nematode detected on *Coffea sp.* in Java by Zimmerman (1989), as *P. coffeae*. Recently, root-lesion nematodes associated with coffee roots tissue were species *P. coffeae* [15]. Otherwise, earlier recorded *Tylenchus coffeae* on silk tree and *Coffea sp.*, and *Tylenchus pratensis* Filip on *Coffea sp.* are presently species *Pratylenchus coffeae* (**Table 1**).

3.2.3. *Tylenchus similis*. *Tylenchus similis* was recorded on black pepper in Roban, Sumatra in 1932, in Bangka, West and SE Kalimantan in 1951; and on tea in Java in 1929. According to Williams and Siddiqi [3], *Tylenchus similis* was one of species synonyms lists for presently *Radopholus similis* (**Table 1**). From recent observation, *R. similis* was detected in Bangka, and on tea in Java, and in Gambung (West Java) based on modern description (sufficient morphological diagnostic value) [15, 26, 27]. Practically, earlier period recorded *Tylenchus similis* Cobb on black pepper and tea is presently species *R. similis*.

3.2.4. *Radopholusoryzae/Tylenchusoryzae*. In the earlier period than Luc & Goodey [28], the rice root nematode was one time recorded as *Radopholus oryzae* (van Breda de Haan) Thorne, 1949 (syn. *Tylenchus oryzae* van Breda de Haan, 1902) on rice/paddy, sugarcane and wild grass. Soon after Lucc and Goodey [28], those species and others were synonymized to *Hirschmanniella oryzae* (**Table 1**). Earlier recorded *Radopholusoryzae* on rice, sugarcane and wild grass are presently species *Hirschmanniella oryzae*.

**Table 1.** Recorded *Tylenchus* spp. on some plants in the period 1898 – 1933 and their nomenclatorial observation results based on synonym scientific names.

Older recorded <i>Pratylenchidae</i> in Indonesia	Preferred species scientific name and common name in present-day position of earlier period recorded nematodes species name
<i>Tylenchus coffeae</i> on silk tree and <i>Coffea</i> sp. [Ann. Rept. 1933: 3, Ann. Rept. 1917: 84 in [4, 5]	<i>PraTylenchus coffeae</i> (Zimmermann, 1898) Filipjev & Shuurmans Stekhoven, 1941 [29] (in CABI Invasive Species Compendium Data Sheet 2018, <a href="https://www.cabi.org/isc/datasheet/43895">https://www.cabi.org/isc/datasheet/43895</a> ). Preferred common name: banana root nematode Synonyms [29]: <i>Anguillulina mahogani</i> (Cobb, 1920) Goodey, 1932; <i>PraTylenchus mahogani</i> (Cobb, 1920) Filipjev, 1936; <i>PraTylenchus musicola</i> (Cobb, 1919) Filipjev, 1936; <b><i>Tylenchus coffeae</i> Zimmermann, 1898</b> ; <i>Tylenchus mahogani</i> Cobb, 1920; <i>Tylenchus musicola</i> Cobb, 1919
<i>Tylenchus pratensis</i> Filip on <i>Coffea</i> sp. [3] <i>Tylenchus pratensis</i> Filip was <i>Tylenchus pratensis</i> (non De Man, 1880): Filipjev and Shuurmans Stekhoven, 1941	<i>PraTylenchus coffeae</i> (Zimmerman, 1898) Filipjev and Shuurmans Stekhoven, 1941 [24]. Synonyms [24]: <i>PraTylenchus coffeae</i> (Zimmerman, 1898); <i>Tylenchus</i> Zimmerman, 1898 Goodey, 1951, Sher & Allen, 1953 (redescription with the neotype designation); <i>Tylenchus musicola</i> Cobb, 1919, Filipjev, 1936b: 81; <i>Tylenchus mahogany</i> Cobb, 1920; <i>Anguillulina mahogany</i> Cobb, 1920; <i>Tylenchus</i> (Chitino <i>Tylenchus</i> ) sp. Schneider, 1938; <b><i>Tylenchus pratensis</i> (non De Man, 1880): Filipjev &amp; Shuurmans Stekhoven, 1941</b>
<i>Tylenchus similis</i> Cobb on black pepper and <i>Tylenchus similis</i> on tea in Java [(Ann. Rept. 1932: 43 in [4, 30, 31]	<i>Radopholus similis</i> (Cobb, 1893) Thorne, 1949 [32]. Preferred common name: Burrowing nematode Synonyms [32]: <b><i>Tylenchus similis</i> Cobb</b> ; <i>Tylenchus granulosus</i> Cobb, 1893; <i>Tylenchus acutocaudatus</i> Zimmerman, 1898; <i>Tylenchus biformis</i> Cobb, 1909; <i>Anguillulina similis</i> (Cobb, 1893) Goodey, 1932; <i>Rotylenchus similis</i> (Cobb, 1893) Filipjev, 1936; <i>Radopholus citrophilus</i> Huettel, Dickson & Kaplan, 1984. Other synonyms exist but are no longer in use [see 33].
<i>Radopholus oryzae</i> Breda de Haan or <i>R. Oryzae</i> (vBrdH) (syn. <i>Tylenchusoryzae</i> ) on rice/paddy, sugarcane and wild grass [34, 35]	<i>Hirschmanniella oryzae</i> (van Breda de Haan, 1902) Luc & Goodey, 1964 [in 36] Preferred common name: rice root nematode Synonyms [36]: <i>Tylenchusoryzae</i> van Breda de Haan, 1902; <i>Tylenchusa papillatus</i> Imamura, 1931; <i>Anguillulina oryzae</i> (van Breda de Haan) T. Goodey, 1932; <i>Rotylenchus oryzae</i> (van Breda de Haan) Filipjev and Shuurmans Stekhoven, 1941; <b><i>Radopholu soryzae</i> (van Breda de Haan) Thorne, 1949</b> ; <i>Hirschmannia oryzae</i> (van Breda de Haan) Luc and Goodey, 1962; <i>Hirschmanniella nana</i> Siddiqi, 1966; nec <i>Tylenchus oryzae</i> Soltwedel, 1889 (nomen nudum)

### 3.3. Nematoda: Cricematidae (ring nematode)

Recorded ring nematode in the modern description period in Indonesia were *Criconemella sp.* and *Macroposthonia ornata* on black pepper, and *Criconemella ornata* on *Citrus sp.* [37, 38]. Those species were also being observed their taxa status, since their taxonomic and nomenclatorial status is controversial [2].

According to Cordero *et al.* [2], many taxonomists including Brezski *et al.* [39, 40] agree that valid genus in *Cricematidae* are: *Criconemoides* Taylor 1936 and *Mesocriconema* Andrassy, 1965. However, some reports in classification, indicated that *Macroposthonia*, *Criconemella*, *Criconemoids* are identical with one another, which those three genera were synonymized with genus *Mesocriconema* [33, 41, 42] (**Table 2**). The results of phylogenetic analysis by Subbotin *et al.* (2005), based on D2-D3 domain indicated monophyly among *Mesocriconema*, *Hemicriconemoides*, and *Criconema* and showed that a representative of the genus *Criconemoides* clustered together with *Mesocriconema* species [36]. CABI Data sheet of Invasive Species Compendium (2018, <https://www.cabi.org/isc/datasheet/16034>) listed *Mesocriconema*, *Macroposthonia*, and *Criconemoides* as synonyms of *Criconemella* [43]. Further, CABI data sheet of Invasive Species Compendium (2018) listed species *Macroposthonia ornata*, *Criconemella ornata*, and *Criconemoides ornatus* as synonyms of presently *Mesocriconema ornate* [43] (**Table 2**). Otherwise *Macroposthonia ornata* on black pepper, and *Criconemella ornata* on *Citrus spp.* that recorded in earlier period are presently species *Mesocriconema ornata*; and *Criconemella sp.* on black pepper is *Mesocriconema sp.*

**Table 2.** Nomenclatorial observation results in classification of the family *Cricematidae* from some references.

References	Taxonomic status of the family <i>Cricematidae</i>
[42]	Genus <i>Criconemoides</i> Taylor, 1936 [42] Synonyms: <b><i>Macroposthonia</i></b> de Man, 1880; <b><i>Criconemella</i></b> DeGrisse&Loof, 1965; <b><i>Mesocriconema</i></b> Andrassy, 1965; <i>Nothocriconemoides</i> Maas, Loof and De Grisse, 1971; <i>Madinema</i> Khan, Chawla &Saha, 1976; <i>Neobakernema</i> Ebsary, 1981; <i>Seshadriella</i> Darekar and Khan, 1981; <i>Pakcriconemoides</i> Shahina and Maqbool, 1993
[43] ( <a href="https://www.cabi.org/isc/datasheet/16034">https://www.cabi.org/isc/datasheet/16034</a> )	Genus <i>Criconemella</i> De Grisse and Loof, 1965 [43] Synonyms: <b><i>Criconemoides</i></b> Taylor, 1936; <i>Crossonemoides</i> Eroshenko, 1981; <b><i>Macroposthonia</i></b> de Man, 1880; <i>Madinema</i> Khan, Chawla and Saha, 1976; <b><i>Mesocriconema</i></b> Andrassy, 1965; <i>Neobakernema</i> Ebsary, 1981; <i>Seshadriella</i> Darekar and Khan, 1981; <i>Xenocriconemoides</i> De Grissea and Loof, 1965
[43] ( <a href="https://www.cabi.org/isc/datasheet/16034">https://www.cabi.org/isc/datasheet/16034</a> )	<b><i>Mesocriconema ornata</i></b> (Raski, 1958) Loof and de Grisse, 1989 [43] Synonyms: <i>Criconemoides ornatus</i> Raski, 1958; <b><i>Macroposthonia ornata</i></b> (Raski, 1958) de Grisse and Loof, 1965; <b><i>Criconemella ornata</i></b> (Raski, 1958) Luc and Raski, 1981; <i>Criconemoides cylindricus</i> Raski, 1952, nec. Kirjanova, 1948; <i>Macroposthonia crassiorbus</i> Patil & Khan, 1983 n. syn

In determining taxa status of the older recorded nematode, nomenclatorial observation was carried out through tracing the species name synonyms or other scientific names of presently species name in all published literatures. Some taxonomist sometimes has different opinion or judgment in nematode classification, because of different results they have in morphological or other diagnostic character differences among species they observed. According to Loof [1], we might explain a thorough realization that one is dealing, not with inanimate objects, but with animal organisms which perform each its own life cycle and forms populations which have their own genetic behavior. Recent recorded PPN taxa status might not include one or some older scientific species name. *Pratylenchus coffeae* synonym list in CABI data sheets (2018), was shorter (some other species name was not included) than those (longer) in Siddiqi [21]; or other possibility, classification by Siddiqi [21] did not include

one older species scientific name *Tylenchus pratensis* (non de Man) Filipjev & Schuurman Stekhoven, but classification by Ryss [24] did include.

#### 4. Conclusions

From classification and nomenclatorial observation on eleven (11) earlier period recorded nematode species, were revealed that species/ genus of *Heterodera* sp., *Heterodera marioni*, *Heterodera radicola*, are presently the genus *Meloidogyne* sp.; *Heterodera javanica* is presently the species *Meloidogyne javanica*; *Tylenchus similis* presently the species of *Radopholus similis*; *Tylenchus coffeae* and *Tylenchus pratensis* Filip are the same presently species *Pratylenchus coffeae*; *Radopholus oryzae* Breda de Haan and *Radopholus oryzae* (vBrdH) are the presently species *Hirschmanniella oryzae*; *Macrophostonia ornata* and *Criconemella ornata* are the same presently species *Mesocriconema ornata*; and *Criconemella* sp. is presently the genus *Mesocriconema* sp..

Since the species scientific name of the nematode could be used in nomenclatorial observation, it is very important to determine and record both the nematode species and its scientific name, in order to provide the right basic data for future taxonomic/nomenclatorial study.

#### References

- [1] Loof P A A 1978 *The genus Pratylenchus Filipjev, 1936 (Nematoda: Pratylenchidae): A review of its anatomy, morphology, distribution, systematics and identification* (Uppsala, Swedish: Sveriges Lantbruks universitet/Swedish University of Agricultural Sciences, Research Information Centre) pp 50. Retrieved from <https://www.cabdirect.org/cabdirect/abstract/19790855475>
- [2] Cordero M A, Robbins R T and Szalanski A L 2012 *J. Nematol.* **44** 399–426
- [3] Zimmerman 1898 *Mededeelingen uit 's Lands plantentuin (s'Graven-hage)* **27** 1–66
- [4] Triharso, Kaselan J and Christanti 1974 *List of Diseases of Important Economic Crop Plants Already Reported in Indonesia* Bulletin No 14 (Jogyakarta: Fakultas Pertanian, Universitas Gadjah Mada) pp 60
- [5] Bally W and Reydon G A 1931 *Arch. Koffiecultuur* **5** 23–216
- [6] Treub M 1885 *Onderzoekingen over Sereh-Ziek Suikerriet gedaan in s'Lands Plantentium te Buitenzorg* (Batavia: Mededeelingen uit 's Lands Plantentium) chapter **2** 1–39
- [7] Jepson S B 1987 *Identification of Root-knot Nematodes (Meloidogyne species)* (UK: CAB International) pp 265
- [8] Chitwood B G 1949 *Proceedings of the Helminthological Society of Washington* **16** 90–104 Retrieved from <https://www.cabdirect.org/cabdirect/abstract/19490801261>
- [9] Whitehead AG 1968 *Taxonomy of J. Zoology* **31** 263–401. Retrieved from <https://doi.org/10.1111/j.1096-3642.1968.tb00368.x>
- [10] Goodey T 1933 *Plant parasitic nematodes* (London: Methuen)
- [11] van der Vecht J 1950 *Nematoda, aaltjes volume 1 De plagen van de cultuur-gewassen in Indonesie* ed L G E Kalshoven pp 15–45
- [12] Williams K J O 1972 *Meloidogyne javanica CIH Descriptions of Plant-parasitic Nematodes* (England: CIH, CAB) Set **1** pp 4
- [13] Pradana A P, Oktafiyanto M F, Eris D D and Munif A 2016 *Prosiding Seminar Nasional Perlindungan Tanaman Perkebunan* (Bogor: Pusat Penelitian dan Pengembangan Tanaman Perkebunan) pp 156–167
- [14] Tuminem 2016 *Disertasi Doktor Pada Program Studi Fitopatologi* (Bogor: Institut Pertanian Bogor) pp 140
- [15] Puskara 2000 *Daftar Organisme Pengganggu Tumbuhan Potensial yang Dilaporkan Telah Terdapat di dalam Wilayah Republik Indonesia* (Jakarta: Pusat Karantina Pertanian) pp 328
- [16] Handoyo H 1982 *Penyakit tebu di Indonesia* (Pasuruan: BP3G) pp 189
- [17] Supratoyo and Mulyadi 1976 *Makalah Kongres Nasional PFI IV* (Bandung: Pusat Penelitian The dan Kina) pp 16

- [18] Bastian H C 1865 *Monograph on the Anguillulidae Trans. Linn. Soc.* **25** 73–184
- [19] Filipjev I N 1934 *Smithson. Misc. Coll.* **89** 1–63
- [20] Sher S A and Allen M W 1953 *University of California Publications in Zoology* (Berkeley, Los Angeles: Univ. of California Press) **57** 441 (Berkeley, Los Angeles: Univ. of California Press) 469
- [21] Siddiqi M R 1972 *Pratylenchus coffeae* CIH *Descriptions of Plant-parasitic Nematodes* (England: CIH, CAB) Set **1** pp 3
- [22] Loof P A A 1974 *Pratylenchus pratensis* C.I.H. *Descriptions of Plant-parasitic Nematodes* (England: CIH St. Albans) Set **4** pp 2
- [23] Corbett D C M 1973 *Pratylenchus penetrans* C.I.H. *Descriptions of Plant-parasitic nematodes* (England: CIH, CAB) Set **2** pp 4
- [24] Ryss A Y 2002 *Zoosyst Rossica* **10** 241–255
- [25] Loof P A A 1960 Taxonomic studies on the genus *Pratylenchus* (Nematoda) *Tijdschr Plantenziekten* **66** 29–9. Retrieved from <http://edepot.wur.nl/393976>
- [26] Momota Y, Djiwanti S R and Oniki M 1990 *Strengthening Research on Diseases of Industrial Crops in Indonesia (ATA 380)* Annual Report No 1 (1990/0110 – 1991/03/31) (Bogor: Balitro) pp 14-23
- [27] Wiryadiputra S 2012 *Warta Pusat Penelitian Kopi dan Kakao Indonesia* pp 9-15
- [28] Luc M and Goodey J B 1964 *Hirschmanniella* nom. Nov. for *Hirschmannia* *Nematologica* **9** (1963) pp 471
- [29] CABI 2018 *Pratylenchus coffeae* (banana root nematode) *Invasive Species Compendium Data Sheet* 2018. Retrieved from <https://www.cabi.org/isc/datasheet/43895>
- [30] Van der Vecht J 1951 *De plagen van de cultuurgewassen in Indonesie* volume 2eds LGE Kalshoven and J van der Vecht (Batavia/Jakarta: W. van Hoeve, The Hague) pp 16-42
- [31] Menzel R 1929 *Archief voor de Theecultuur* **1** 11–66
- [32] Williams K J O and Siddiqi M R 1973 *Radopholus similis* CIH *Descriptions of Plant-parasitic Nematodes* (England: CIH, CAB) Set **2** pp 4
- [33] Siddiqi M R 2000 *Tylenchida parasites of plants and insects* (St. Albans, UK: Commonwealth Agricultural Bureaux Publishing) pp 645
- [34] Breda de Haan J van 1902 Een aaltjes-ziekte der rijst “omo mentek” of “omo Bambang” *Meded. Lds Pl Tuin, Batavia* **53** pp 66
- [35] Van der Vecht J and Bergman B H H 1952 *Pemberitaan Balai Besar Penyelidikan Pertanian* **131** 1–82
- [36] Siddiqi M R 1973 *Hirschmanniella oryzae* CIH *Descriptions of Plant-parasitic Nematodes* (England: CIH, CAB) Set **2** pp 3
- [37] Bridge J 1989 Plant Parasitic Nematodes of Citrus in East Java, Bali and South Sulawesi *Final Technical Report of Visit to FAO Citrus Rehabilitation Project, Malang, East Java* (UK: CAB International Institute of Parasitology) pp 10
- [38] Bridge J 1978 Plant nematodes associated with cloves and black pepper in Sumatra and Bangka, Indonesia *ODM Technical Report on Visit to Indonesia, July 9-19th, 1978* (UK: Ministry of Overseas Development) pp 19
- [39] Brzeski M, Loof P A A and Choi Y E 2002 *Nematology* **4** 325–339
- [40] Brzeski M, Loof P A A and Choi Y E 2002 *Nematology* **4** 341–360
- [41] Decraemer W and Hunt D 2006 Structure and classification *Plant Nematology* eds R N Perry and M Moens (UK: CAB International) pp 3-32
- [42] Vera I C P and Talavera M 2007 Criconematoidea Practical plant nematology *A field and Laboratory Guide* eds D L Coyne, J M Nicol, B Claudius-Cole (Cotonou, Benin: International Institute of Tropical Agriculture) chapter 13 pp 478-519
- [43] CABI 2018 *Criconemella* (ring nematode) *Invasive Species Compendium CABI Data sheet Type (s)*. Retrieved from <https://www.cabi.org/isc/datasheet/16034> Last modified 14 July 2018