PROPOSAL TO STABILISE THE SCIENTIFIC NAME OF THE
CEREAL-ROOT EELWORM (CLASS NEMATODA). Z.N.(S.) 375.

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The object of the present application is to stabilise the nomenclature of the cereal-root eelworm, a widespread species of great economic importance which is now known by two different names in different countries.

2. The Nematode genus *Heterodera* A. Schmidt, 1871* contains several species, all of them parasitic on the roots of plants, and all having a cystic stage in the life-history. They were at one time considered to be a single species, *H. schachtii* A. Schmidt, 1871, mainly parasitising sugar-beet, but having biologic races on other crop plants, notably (in the present connection) on cereals.

3. From time to time workers in this subject have raised one or other of the biologic races of *H. schachtii* to the rank of variety, subspecies or species, but these opinions were not generally accepted until one of us (M.T.F.) in 1940 described slight morphological differences between three of these races and raised them to specific rank under the names *H. major* O. Schmidt (the cereal "race"), *H. rostochiensis* Wollenweber (the potato "race") and *H. goettingiana* Liebscher (the pea "race"). The splitting of the wider concept of *H. schachtii* is now generally accepted among nematologists, but there is a lack of uniformity of usage in the name applied to the cereal-root eelworm. American, Canadian, Dutch, German, Israeli, Russian and some Italian authors use the specific name *avenae* for this pest, while British, Danish, Japanese and other German and Italian authors use the specific name *major* O. Schmidt, 1930. The analysis of usage since 1940 given in Appendix I to the present paper shows that the specific name *major* has been used in 44 works and the specific name *avenae* in 21 works published in the period reviewed, and that usage is divided cleanly on national grounds except that some Italian and German authors use one name and some the other.

4. German and Danish workers were the first to recognise that the cyst-forming *Heterodera* which damaged cereals behaved differently from other known forms of the genus, especially from the beet eelworm, *H. schachtii* (see Voigt, 1892 ; Hansen, 1904). Voigt recorded morphological differences between the "Hafernematode" and the "Rübennematode" which enabled him to distinguish between the two taxa, but he did not publish a name for the former. In Danish publications, occurrences of the oat eelworm ("Havreaal") were frequently reported from 1895 onwards and Mortensen, Rostrup &

* The generic name *Heterodera* A. Schmidt, 1871 was added to the Official List of Generic Names in Zoology in Opinion 104 and the specific name *schachtii* A. Schmidt, 1871 to the Official List of Specific Names in Zoology in Direction 77.

Kølpin Ravn (1908, *Tidsskr. Landbr. Planteavl*, **15** : 145–158, see p. 151) were the first to use for it the name *Heterodera schachtii* var. *avenae*, but they gave only a record of the occurrence of the worm without any description. The oat eelworm had in fact been described by Hansen in the same Journal in 1904, but he gave no name and his description is not referred to by Mortensen, Rostrup & Kølpin Ravn.

5. The subspecific name *avenae* was regularly mentioned as a *nomen nudum* in the annual reviews of the occurrence of plant diseases and pests in Denmark for the years 1907 to 1925. Wollenweber (1934, *Illustr. Landwirtsch. Z.* No. **12** : 101) stressed the physiological and morphological differences between *H. schachtii* var. *avenae* (Haferälchen) and *H. schachtii* (Rübenälchen) and gave a table of measurements showing the size-differences between the "female worms (cysts)" of *H. radiculicola* (Greeff) Müller [= *Meloidogyne* spp.], *H. rostochiensis* Wollenweber, *H. schachtii* var. *avenae* and *H. schachtii* A. Schmidt. A translation of his description read: "*Heterodera schachtii* var. *avenae*, the oat eelworm, clearly occupies a middle place between the beet and the root [-knot] nematodes, but which [place] has yet to be decided". Wollenweber is here evidently referring to the figures given in his table which indicate that in the ratios of body length/width and body plus neck length/width the cereal eelworm cysts resemble cysts of *H. schachtii* and differ from those of *H. rostochiensis* and from females of root-knot eelworm, whereas in neck length and ratio of body length/neck length the cereal eelworm cysts are nearer *H. rostochiensis* than *H. schachtii* (see Table).

Species or variety	Host plant	Female eelworms (cysts)								Stylet	
		Eggs		Body		Body L		Total L	Neck L		Body L
		L	W	L	W	width	width				
<i>Heterodera</i>											
<i>radiculicola</i>	Potato	80	44	553	479	1.2	1.4	137	4.0	15	
<i>H. rostochiensis</i>	Potato	97	46	655	640	1.0	1.2	137	5.0	—	
<i>H. schachtii</i>											
var. <i>avenae</i>	Oats	—	—	526	334	1.6	1.6*	120	4.4	23	
<i>H. schachtii</i>	Beet	106	45	686	440	1.6	1.7	84	8.2	29	
<i>H. schachtii</i>	Cabbage	115	43	667	425	1.6	1.9**	81	8.2	28	

* This is an error and should read 1.9.

** This is an error and should read 1.76
Measurements in μ .

We hold that by using the name in connection with differential measurements of the cysts of the females, coupled with a reference to the host plants, Wollenweber gave the status of availability to the subspecific name *avenae*. Cyst measurements alone are now known to be of little use for identification in this case, particularly when there is no indication of the number of measurements made and when immature female cysts are taken. (Stylet measurements are given, but in *mature* cysts the stylet is no longer visible.) Mention of the host plants alone (such as had frequently been given in the past by other writers) would not have sufficed for this purpose, though this evidence was, and still is, sufficient to identify the cereal root eelworm in practice without ambiguity.

Wollenweber, however, appears to have recognized that there were morphological differences between beet and oat eelworms, and he attempted to indicate what these differences were.

6. In 1930 Schmidt (O.) (*Pflanzenbau* 3 : 420–464) published a thorough analysis of the differences between the larvae of the beet eelworm and the oat eelworm, based on 40,000 measurements of larvae from 60 populations, and described the morphological, host-preference and hatching-rhythm differences between the two. He divided the larvae into two groups, named *H. schachtii* var. *major* and var. *minor* respectively, and there is no doubt of the availability of both names as from his work. In 1934 Filipjev ([*Nematodes beneficial and harmful to agriculture*] in Russian, see p. 237) summarized O. Schmidt's work and reproduced some of his illustrations. He used the name *avenae* as a specific name. Neither O. Schmidt nor Filipjev quoted Wollenweber's work, but whereas Schmidt gave no indication that he knew of the earlier Danish records, Filipjev specifically mentions them. According to correspondence with Bovien in 1937, however, Filipjev was uncertain about the availability of the name *avenae*.

7. In 1940 Franklin (*J. Helminth.* 18 : 193–208) used the binomen *H. major* O. Schmidt for the oat eelworm, being at that time unaware of Wollenweber's work in which the name *avenae* had first been published as an available name. In 1957 (*Nematologica* 2 : 149–151), still without having seen Wollenweber's work, she held that *H. major* was the first name to have been validly published for the species, but noted the extensive prior use of *avenae*, and added : "It should, however, be emphasised that the important point is not so much *which* name should be adopted, but that only *one* name should be used, and that that one should be chosen in accordance with the International Rules of Zoological Nomenclature. Unless, therefore, some relevant publication or reference has been overlooked, it is clear that the correct name for the cereal-root eelworm is *Heterodera major* (O. Schmidt, 1930) Franklin, 1940". In the same year she enquired of Mr. Hemming, then Secretary to the Commission, whether that name or *Heterodera avenae* should be used for the cereal-root eelworm and she repeated her enquiry in February, 1958 (having then seen Wollenweber's paper and drawing the Secretary's attention to it), but at that time the resources of the Commission's office were devoted to the preparations for the London Colloquium and the publication in book-form of the Official Lists and Indexes.

8. In June, 1958, the two other authors of the present application approached the Commission (independently of Dr. Franklin) for a ruling on the validity of the name *avenae* as the name of the cereal-root eelworm, and correspondence between the three applicants and the office of the Commission has resulted in this joint application.

9. While it is obvious that Schmidt's work appears to be thorough and careful, it is in fact of less practical use to agricultural nematologists. The majority of these workers, when confronted with females and brown cysts associated with the roots of cereals, find that the criteria given by Wollenweber are practical and satisfactory aids to identification, coupled with his statement that the species infests oats, barley, wheat and rye. Schmidt based the name *major* on the greater length of "oat eelworm" larvae compared with "beet

eelworm" larvae and supported this with numerous measurements which were later confirmed by Fenwick & Franklin (1951). But statistical analysis of great numbers of larvae is not a feasible method of identification for the ordinary worker. An experienced worker can judge by eye, on releasing larvae from a cyst, whether they are those of the oat eelworm or of the beet eelworm, if he has to choose between those two. One of us (M.O.), however, indicates that a strain of *Heterodera schachtii* on *Spergula arvensis*, which is found at different localities in the Netherlands and also occurs in Germany, has larvae which are as long as or longer than the oat eelworm (522–600 μ), though it can be separated from the oat eelworm on cyst form and other characters. It is therefore advisable to rely on the practical application of cyst-form and other characters as indicated under paragraph 11, in addition to host plant, and to use larval length with caution as an additional character.

10. It will be seen from the figures given in Appendix I that most of the references to *H. major* are from England, where most of the work on the species has been done. If workers in that country could be persuaded to adopt the name *avenae*, world usage would be preponderantly in favour of that name. It may also be pointed out that one of us (M.O.) has used the name *avenae* in describing morphological characters overlooked by previous authors by which the cereal-root eelworm can be readily recognized (Oostenbrink & den Ouden, 1954).

11. The material described by Wollenweber and O. Schmidt cannot be traced, and it is unlikely that the older Danish records were based on material stored in collections. It is therefore proposed to designate a neotype for the species. This specimen, which is shortly described in Appendix II, is deposited in the nematology collections of the Plantenziektenkundige Dienst, Wageningen, Netherlands, where specimens agreeing with the neotype will be kept available for distribution to other nematology centres on request. The oat eelworm, *Heterodera avenae* Wollenweber, 1924, as described from the type material mentioned above, differs from other known *Heterodera* species by the following characters: A broad lemon-shaped cyst with a low, tapering vulval cone and with an extremely short vulval slit (12 μ). Cyst wall thick ($\pm 9 \mu$), brown to black, with conspicuous irregular punctation; young cysts with a thick subcrystalline layer. Larvae on an average well above 500 μ long, with a slightly curved, long tail ($\pm 1\frac{1}{2} \times$ stylet length) and with a distinctly tapering head which appears rounded owing to the narrow (8–9 μ) lip.

12. We therefore request the International Commission:—

- (1) to rule that neither the name *minor* O. Schmidt, 1930, as published in the combination *Heterodera schachtii* subsp. *minor*, nor the name *major* O. Schmidt, 1930, as published in the combination *Heterodera schachtii* subsp. *major*, is to be used in preference to the name *avenae* Wollenweber, 1924, as published in the combination *Heterodera schachtii* var. *avenae*, by those zoologists who consider that all of those names apply to the same taxon;
- (2) to rule that the nominal species *Heterodera avenae* is to be interpreted by reference to the neotype described in Appendix II to this application and made available for further study as indicated.

- (3) to place the subspecific name *avenae* Wollenweber, 1924, as published in the combination *Heterodera schachtii* A. Schmidt var. *avenae*, on the Official List of Specific Names in Zoology.

APPENDIX I

*Literature on the Cereal Root Eelworm*I. Papers in which the cereal root eelworm is referred to as *Heterodera avenae*.

(Numbers are the numbers given to the papers in the following list A.)

Country of Author	Papers entirely about <i>H. avenae</i>	Papers on <i>Heterodera</i> spp. including <i>H. avenae</i>	Brief mention of <i>H. avenae</i> amongst other nematodes	Total
Canada	1, 11	10	—	3
Germany	19	16, 21	4	4
Holland	3, 7, 8	5, 15	12, 13, 14	8
Israel	—	9	—	1
Italy	—	—	2	1
U.S.A.	—	—	17, 18, 20	3
U.S.S.R.	—	—	6	1
Totals	6	6	9	21

12 papers
by 10 authors from
4 countries

II. Papers in which the cereal root eelworm is referred to as *Heterodera major*.

(Numbers are the numbers given to the papers in the following list B.)

Country of Author	Papers entirely about <i>H. major</i>	Papers on <i>Heterodera</i> spp. including <i>H. major</i>	Brief mention of <i>H. major</i> amongst other nematodes	Total
Britain	2, 10, 12a, 16, 17, 18, 19, 19a, 24, 33, 34, 35, 36, 38	7, 11, 12, 15, 21, 26, 30, 37, 39, 40, 41	6, 14, 22, 23, 28, 31, 32	32
Denmark	1, 1a, 3, 5	—	4	5
Germany	8, 13	—	—	2
Ireland	9	—	—	1
Israel	—	—	29	1
Italy	27	—	—	1
Japan	—	20	—	1
U.S.A.	—	—	25	1
Totals	22	12	10	44

34 papers
by 23 authors from
8 countries.

Totals refer to the number of papers listed in the respective lines of columns.

Columns 2 and 3 are the important ones : papers listed in column 4 are general ones.

Distribution of the cereal root eelworm is in all countries in the first column, except the United States of America.

A. Papers in which the name *Heterodera avenae* is used.

C=Canada G=Germany H=Holland Is=Israel It=Italy

- 1 C Baker, A., & Chapman, L. J. 1946. "The oat nematode in Ontario." Processed Publication, Div. of Ento., Dept. Agric. Canada, No. 29, 4 pp.
- 2 It Baresi, F. 1955. "La lotta contro le anguillule delle foglie dei crisantemi mediante l'insetticida sistemico selettivo 'Systox'." Notiziario sulle Malattie delle Piante, Milan, No. 29, 3-7. (General paper on control.)
- 3 H Dijkema, L. R. 1947. "Eenige waarnemingen met betrekking tot eenzijdige graanbouw." *Tijdschr. PlZiekt.* 53(1) : 16-18
- 4 G Goffart, H. 1951. "Methoden zur Untersuchung von Böden auf Kartoffelälchen." *NachrBl. dtsh. PflSchDienst, Stuttgart* 3(2) : 25-27. (Chief subject is *H. rostochiensis*, *H. avenae* is mentioned incidentally.)
- 5 H Hijner, J. A., Oostenbrink, M., & den Ouden, H. 1953. "Morphologische verschillen tussen de belangrijkste *Heterodera*-soorten in Nederland." *Tijdschr. PlZiekt.* 59 : 245-251
- 6 USSR Kirjanova, E. S. 1951. [Variations in plant nematodes under the influence of food specialization.] *Trud. zool. Inst. Akad. Nauk SSSR* 9(2) : 378-404 [In Russian]
- 7 H Kort, J. 1957. "Het voorkomen van het haver cystenaaltje (*Heterodera avenae* Filipjev 1934=*H. major* Schmidt, 1930) in Nederland." *Versl. PlZiekt. Dienst Wageningen* No. 130, 143-146
- 8 H Kort, J., & s'Jacob, J. J. 1956. "Een oriënterend onderzoek naar het voorkomen van en de schade veroorzaakt door het haver cystenaaltje (*Heterodera avenae*=*H. major*) in 1955." *Tijdschr. PlZiekt.* 62 : 7-11
- 9 Is Minz, G. 1956. "Cyst-forming nematodes in Israel." *Pl. Dis. Reprtr.* 40(11) : 971-973
- 10 C Mulvey, R. H. 1957. "Taxonomic value of the cone top and the underbridge in the cyst-forming nematodes *Heterodera schachtii*, *H. schachtii* var. *trifolii* and *H. avenae* (Nematoda : Heteroderidae)." *Canad. J. Zool.* 35(3) : 421-423
- 11 C Mulvey, R. H. 1959. "Preliminary studies on oogenesis in a cyst-forming nematode, *Heterodera avenae* (Nematoda : Heteroderidae)." *Nematologica* 4(1) : 1-2

- 12 H Oostenbrink, M. 1953. "Actuele waarnemingen en meldingen op nematologisch gebied." *Versl. PlZiekt. Dienst Wageningen* No. 120, 165-175. (*H. avenae* mentioned once in a paragraph on *Heterodera* species.)
- 13 H Oostenbrink, M. 1954. "Een overzicht van de nematologie als onderdeel van de plantenziektenkunde." *Landbouwvoorlichting* 11(5) : 215-226. (One paragraph deals with *H. avenae* in this general paper.)
- 14 H Oostenbrink, M. 1957. "Das Vorkommen von Artgemischen bei pflanzenparasitären Nematoden." *Nematologica* 2 (Suppl.) : 342-346 (*H. avenae* mentioned once)
- 15 H Oostenbrink, M., & den Ouden, H. 1954. "De structuur van de kegeltop als taxonomisch kenmerk bij *Heterodera*-soorten met citroenvormige cysten." *Tijdschr. PlZiekt.* 60 : 146-151
- 16 G Scherney, F. 1957. "Morphologische und histologische Untersuchungen an *Heterodera*-Arten." *Z. PflKrankh.* 64(3) : 131-139
- 17 USA Steiner, G., Taylor, A. L., & Cobb, G. S. 1951. "Cyst-forming plant parasitic nematodes and their spread in commerce." *Proc. helminth. Soc. Wash.* 18(1) : 13-18 (*H. avenae* mentioned once)
- 18 USA USDA, Annual Report for 1950-51 of Bureau of Plant Industry, Soils and Agricultural Engineering. "Nematology investigations." Year 1950-1951, pp. 425-427
- 19 G Wagner, F. 1952. "Über Auftreten und Bekämpfung des Haferälchens (*Heterodera avenae*)." *Pflanzenschutz*, 4(7) : 83-85
- 20 USA Wheeler, W. H. 1949. "Interceptions of the genus *Heterodera* in foreign soil." *Pl. Dis. Repr.* 33(12) : 446
- 21 G Wieser, W. 1953. "On the structure of the cyst wall in four species of *Heterodera* Schmidt." *Medd. Vårtskyddsanst. Stockh.* No. 65, 15 pp.

B. Papers in which the name *Heterodera major* is used.

B=British D=Danish G=German It=Italian J=Japanese
Is=Israel Ir=Ireland USA=U.S.A.

- 1 D Andersen, S. 1956. "Collection of cysts of *Heterodera major* and estimation of the cyst content." *Nematologica* 1(4) : 303-306
- 1a D Andersen, S. 1959. "Resistance of barley to various populations of the cereal root eelworm (*Heterodera major*)." *Nematologica* 4(2) : 91-98
- 2 B Anon. 1957. "Cereal root eelworm." Advisory Leaflet No. 421, Min. of Agric. Fish. & Food, pp. 4
- 3 D Borg, A. 1952. "Angrepp av nematoder på havre." *Vårtskyddsnotiser, Stockh.*, Year 1952 (5/6), 69-74
- 4 D Bovien, P. 1950. "Plantesygdomme i Danmark 1947. 8. Skadedyr på havebrugsplanter." *Tidsskr. Planteavl* 53(2) : 212-223

- 5 D Bovien, P. 1953. "Om havreålen (*Heterodera major*) og resultaterne af nogle forsøg på smittet jord." *Tidsskr. Planteavl* 56(4) : 581-591
- 6 B Cameron, A. E. 1946. "Insect and other pests of 1945." *Trans. Highl. agric. Soc. Scot.* Ser. 5, 58 : 101-120. (One paragraph on *H. major*)
- 7 B Cooper, B. A. 1955. "A preliminary key to British species of *Heterodera* for use in soil examination." *Soil Zoology, Proc. Univ. Nott. 2nd Easter School in agric. Sci.*, 1955, pp. 269-280. Butterworths, London
- 8 G Dieter, A. 1958. "Beobachtungen über *Heterodera major* O. Schm. an Hafer." *NachrBl. dtsh. PflSchDienst, Berl.* N.F. 12(8) : 155-158
- 9 Ir Duggan, J. J. 1958. "Population studies on cereal root eelworm *Heterodera major* (O. Schmidt, 1930)." *Econ. Proc. Roy. Dublin Soc.* 4(6) : 103-118
- 10 B Dunn, E. 1957. "Cereal root eelworm." *Scot. Agric.* 36(3) : 146-148
- 11 B Fenwick, D. W. 1956. "Nematology Department." Report of the Rothamsted Experimental Station, Year 1955, pp. 107-111 (see p. 111)
- 12 B Fenwick, D. W., & Franklin, M. T. 1951. "Further studies on the identification of *Heterodera* species by larval length. Estimation of the length parameters for eight species and varieties." *J. Helminth.* 25(1/2) : 57-76
- 12a B Fidler, J. H., Church, B. M., & Southey, J. F. 1959. "Field sampling and laboratory examination of cereal root eelworm cysts." *Plant Pathology* 8(1) : 27-34
- 13 G Goffart, H. 1939. "Zur Lebensgeschichte von *Heterodera schachtii maior* (Nematodes)." *Zbl. Bakt., Abt. 2*, 99 : 394-399
- 14 B Goodey, T. 1956. "The nematode parasites of plants catalogued under their hosts." *Commonw. Bur. agric. Parasit. (Helminth.)*, St. Albans, Revised by J. B. Goodey & M. T. Franklin, 140 pp.
- 15 B Hague, N. G., & Hesling, J. J. 1958. "Population studies on cyst-forming nematodes of the genus *Heterodera*." *Proc. linn. Soc. London* 169(1/2) : 86-92
- 16 B Hesling, J. J. 1956. "Some observations on *Heterodera major*." *Nematologica* 1(1) : 56-62
- 17 B Hesling, J. J. 1957. "The hatching response of *Heterodera major* (O. Schmidt) to certain root diffusates." *Nematologica* 2(2) : 123-125
- 18 B Hesling, J. J. 1957. "*Heterodera major* O. Schmidt on cereals—a population study." *Nematologica* 2(4) : 285-299
- 19 B Hesling, J. J. 1958. "*Heterodera major* O. Schmidt, 1930—Population changes in the field and in pots of fallow soil" *Nematologica* 3(4) : 274-282

- 19a B Hesling, J. J. 1958. "The efficiency of certain grasses as hosts of cereal root eelworm." *Plant Pathology* 7(4) : 141-143
- 20 J Ichinohe, M. 1955. [Studies on the morphology and ecology of the soy bean nematode, *Heterodera glycines*, in Japan.] Report of the Hokkaido National Agricultural Experimental Station, No. 48, 64 pp. [In Japanese : English summary pp. 59-64]
- 21 B Jones, F. G. W. 1950. "Observations on the beet eelworm and other cyst-forming species of *Heterodera*." *Ann. appl. Biol.* 37(3) : 407-440
- 22 B Jones, F. G. W. 1957. "Nematology Department." Report of the Rothamsted Experimental Station, Year 1956, pp. 121-126, see p. 124
- 23 B Jones, F. G. W. 1958. "Nematology Department." Report of the Rothamsted Experimental Station, Year 1957, pp. 124-130, see p. 128
- 24 B Jones, F. G. W., & Moriarty, F. 1956. "A preliminary experiment on the effect of various cereals on the soil population of cereal root eelworm, *Heterodera major* O. Schmidt." *Nematologica* 1(4) : 326-330
- 25 USA Krusberg, L. R., & Hirschmann, H. 1958. "A survey of plant parasitic nematodes in Peru." *Plant Dis. Reprtr.* 42(5) : 599-608. (*H. major* mentioned amongst many other nematodes)
- 26 B Lapage, G. 1956. "The potato-root eelworm and other species related to it." *Sch. Sci. Rev.* 37(133) : 321-336 (Brief account of *H. major*)
- 27 It Mezetti, A. 1953. "Osservazioni sull'anguillulosi radicale dei cereali in Italia." *Ann. Sper. agr.*, Nuova serie 7(3) : 743-758
- 28 B Miles, H., & Miles, M. 1954. "Root eelworms." *New Biol.* No. 16, 101-117. (General and popular account.)
- 29 Is Minz, G. 1957. "Crop damage by nematodes in Israel." *Nematologica* 2 (Suppl.) : 405S. (*H. major* mentioned)
- 30 B Peters, B. G. 1952. "The eelworm problem : biological aspects. Plant eelworms of the genus *Heterodera*." *Chem. & Ind.*, London, Year 1952, No. 41, 994-995
- 31 B Peters, B. G. 1954. "Nematology Department." Report of the Rothamsted Experimental Station, Year 1953, pp. 97-102
- 32 B Peters, B. G. 1955. "Nematology Department." Report of the Rothamsted Experimental Station, Year 1954, pp. 96-102
- 33 B Southey, J. F. 1956. "National survey work for cereal root eelworm (*Heterodera major* (O. Schmidt) Franklin)." *Nematologica* 1(1) : 64-69
- 34 B Southey, J. F. 1956. "The cereal root eelworm." *The Agricultural Review* 2(7) : 39-40
- 35 B Stone, L. E. W. 1956. "Cereal root eelworm : a farm survey." *Plant Path.*, Lond. 5(1) : 24-25

- 36 B Thomas, I., Brown, E. B., & Willis, R. J. 1946. "The cereals root eelworm, *Heterodera major* (O. Schmidt) Franklin, in North Wales." *Ann. appl. Biol.* **33**(1) : 63-65
- 37 B Wallace, H. R. 1958. "Observations on the emergence from cysts and the orientation of larvae of three species of the genus *Heterodera* in the presence of host plant roots." *Nematologica* **3**(3) : 236-243
- 38 B White, J. H. 1957. "Cereal root eelworm in Durham, 1955." *Plant Path., Lond.* **6**(3) : 107-108
- 39 B Winslow, R. D. 1954. "Provisional lists of host plants of some eelworms (*Heterodera* spp.)." *Ann. appl. Biol.* **41**(4) : 591-605
- 40 B Winslow, R. D. 1955. "The hatching responses of some root eelworms of the genus *Heterodera*." *Ann. appl. Biol.* **43**(1) : 19-36
- 41 B Winslow, R. D. 1955. "A new method for the production and recovery of cysts of root eelworms (*Heterodera* spp.) for use in bio-assay." *J. Helminth.* **29**(1/2) : 49-54

APPENDIX II

Description of Neotype—by M. Oostenbrink.

(Locality—Aschersleben, Germany.)

A mature cyst with eggs and larvae on slide *Heterodera* f 141. Neoparatypes on slides *Heterodera* f 133-140 and 142-152. The slides are deposited in the Nematology Collection of the Plantenziektenkundige Dienst, Wageningen, Netherlands, where they are available for study.

The neotype cyst has been cracked open so that more differential characters are readily seen. The cyst is clearly lemon-shaped, has a typical short vulval slit (12 μ long) and is brown to black with conspicuous punctation. The cyst wall is 9 μ thick. About 250 eggs and 15 larvae are visible. The eggs measure 126 μ long by 56 μ wide (mean of 20 specimens) and the larvae average 530 μ long (8 specimens). The larval tails are slightly curved and are about $1\frac{1}{2}$ times as long as the mouth stylet. The heads are tapering and rounded, with the lip region 3.9 μ high and 8.5 μ broad (average of 10 specimens). The larval stylets average 25 μ long (10 specimens).

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