prepared by specially designated reporters for various subjects. These reports try (*try* is the proper word, as the reviewer knows and as may be read in so many words or between the lines in the reports themselves) to cover the progress in the designated subject for the three years preceding. The present volume contains the following reports intended for the Lisbon meeting and covers the calendar years 1931–1933, inclusive:

"Precise Leveling," J. Vignal and R. Taton (France). 155 pages.
"Latitude, Longitude and Azimuth and Geodetic Applications of Wireless Telegraphy," H. L. P. Jolly (Great Britain). 144 pages.
"Deflections of the Vertical," K. Wold (Norway). 27 pages.
"Gravity on Land," E. Soler (Italy). 107 pages.
"Gravity at Sea," F. A. Vening Meinesz (Netherlands). 11 pages.
"Isostasy," W. Heiskanen (Finland). 51 pages.
"Projections," H. Roussilhe (France). 38 pages.
"Earth Tides," W. D. Lambert (U. S. A.). 19 pages.

Triangulation and base measurement seem obvious omissions, for they are the backbone of geodesy, but there were difficulties in completing reports on these subjects and a full report is promised for a later date, to include the data submitted for the General Assembly at Edinburgh in 1936. The report by Kimura on the variation of latitude is included in the national report of Japan.

There is much of interest and value in these reports, but detailed comment would take much space and would require the concentration of an unusual amount of specialized knowledge in one reviewer. The manner of treatment is as varied as the subjects and the nationality of the reporters. Two general comments suggest themselves:

(1) One purpose of the Association is to attain some degree of uniformity in notation, nomenclature and methods of procedure. It might be feared that this desired uniformity would in time be overdone, but these reports afford no indication that this fear is justified.

(2) Geodesy is an old science, dating, let us say, from the time of Eratosthenes (200 B.C.), but it is far from being a finished body of doctrine. There are plenty of problems still awaiting solution.

WALTER D. LAMBERT

SPECIAL ARTICLES

STIMULATED ACTIVITY OF NATURAL ENEMIES OF NEMATODES[1]

SOROKIN,[2] Zopf[3] and others long ago recorded the destruction of nematodes by fungal parasites or by fungi which trap nematodes with specialized organs of capture, then penetrate and consume them. Recently, Drechsler[4, 5, 6] has added greatly to the list of nema-capturing fungi and to an understanding of their means of capture.

Many of the nema-capturing fungi grow freely as saprophytes, most of them produce aerial conidia, and several are also disseminated by the movement of nematodes carrying detached fragments of fungus. Most of them appear relatively non-specific, capturing nematodes of several genera apparently with equal ease. Likewise, at least some of the non-trapping parasites are non-specific, but others may attack only certain genera or related genera of nematodes.

Most of the fungi reported by Drechsler have thus far been reported only from the vicinity of Washington, D. C. *Arthrobotrys oligospora* Fresenius and several parasites, however, have been recorded from various parts of Europe. The lack of more numerous reports probably results from lack of adequate search with appropriate techniques.

Since October, 1935, the writer and associates have recognized over 20 nema-destroying fungi, including simple parasites and trappers in Hawaiian field, garden and forest soils. Many of them destroy larvae of *Heterodera marioni* (Cornu) Goodey as readily as they do nematodes formerly reported to be attacked. A very superficial survey has shown certain of them to be wide-spread in the Hawaiian Islands. One or more has been found in every old pineapple field thus far sampled adequately, while a plot of approximately two acres which has been sampled more intensively has yielded 15 distinct forms. Several of these fungi appear identical with forms described elsewhere, including *Arthrobotrys oligospora* Fresenius, *Catenaria anguillulae* Sorokin, *Harposporium anguillulae* Lohde, *Stylopage hadra* Drechsler and forms similar to or identical with Drechsler's[7] numbers, 4, 5, 7, 12, 13 and 15. Several others appear to be undescribed.

Even in the plot in which 15 such fungi have been

1 Published with the approval of the director as Technical Paper No. 94 of the Pineapple Experiment Station, University of Hawaii.
2 N. Sorokin, *Ann. d. Sci. Nat. Bot.*, Ser. 6, 4; 62–71, 1876.
3 W. Zopf, *Nova Acta Ksl. Leop.-Carol. Deutschen Akad. Naturforscher*, 47 (4): 167–168, 1884; 52 (7): 314–341, 1888.
4 C. Drechsler, *Jour. Washington Acad. Sci.*, 23: 138–141, 267–270, 355–357, 1933.
5 C. Drechsler, *Mycologia*, 26 (2): 135–144, 1934.
6 C. Drechsler, *Mycologia*, 27 (2): 206–215, 1935.
7 See footnote 4.

found, the root knot nematode, *Heterodera marioni*, is still securely established, although less abundant than in some other pineapple fields. Apparently, extermination of plant parasitic nematodes by such fungi is not to be expected. Laboratory and glasshouse experiments have, however, demonstrated the possibility of so increasing the activity of these fungi that they assume some practical significance in control of *H. marioni*.

Incorporation of fresh plant material into soil is followed by a rapid rise in the total population of free-living nematodes. A 65-fold increase was recorded after 14 days in one experiment, with *Aphelenchus avenae* Bastian, *Aphelenchoides parietinus* Bastian, *Cephalobus* spp., and *Rhabditis* spp. all abundant. Parasites and trappers were conspicuous in association with these nematodes when washed from the soil for counting. Within 21 days the nematode population was greatly reduced and nema-destroying fungi were still more conspicuous. Such fungi included at least 3 trappers and 2 non-trapping parasites. Ample confirming evidence establishes the fact that as the total nematode population increases, the natural enemies of nematodes so increase their activity that the multiplication of nematodes, favored by an abundant food supply, is overbalanced.

During a period of such increased activity of nema-destroying fungi, one might expect the larvae of obligate plant-parasitic nematodes, unable to reproduce under these conditions, to be reduced in numbers. Experiments have demonstrated this to be the case with *H. marioni*.

In a series of laboratory and glasshouse tests, chopped pineapple plant material has been mixed with naturally infested field soil and allowed to decompose

TABLE I

REDUCTION OF POPULATIONS OF INFECTIVE LARVAE OF *Heterodera marioni* IN NATURALLY INFESTED SOIL DURING DECOMPOSITION OF CHOPPED PINEAPPLE PLANT MATERIAL, MEASURED BY GALL COUNTS ON WHIPPOORWILL COWPEA INDICATOR PLANTS

Experiment No.	Rate* of application	Duration of decomposition (weeks)	Frequency† of mixing (weeks)	Galls per 2400 g. soil	
				Check	Decomposition
1	200	12	1	611 ± 46.5	2.0 ± 0.8
5	200	12	1	190 ± 14.0	27.0 ± 5.3
	150	12	1	"	21.0 ± 3.0
	100	12	1	"	31.0 ± 5.0
	50	12	1	"	66.0 ± 15.3
6	150	12	3	1415 ± 153.5	98.0 ± 13.2
	150	12	1	1036 ± 93.5	90.0 ± 11.5
9	150	4	2	7314 ± 525.3	425.0 ± 62.0
		8	2	2229 ± 237.6	609.0 ± 63.4
		12	2	5297 ± 431.8	982.0 ± 173.8

* Tons per acre foot equivalent of the amounts actually added to 2400 g. quantities of soil.
† Mixing consisted of a mild shaking of the soil jars.

under favorable conditions of temperature and moisture during various periods of time prior to the measurement of surviving populations of infective larvae by the indicator plant method. The soils thus far used are from pineapple fields in two localities on the island of Oahu. Summarized results are presented in Table I.

In each instance the check soil was held under laboratory conditions during the period allowed for decomposition in the treated soils, with no host plants present. Striking reductions in populations of infective larvae have been observed in every experiment. Statistical treatment, following Miles,[8] based on standard error of difference, shows odds greater than 1999 : 1 for every comparison of decompositon and check in Table I. No less significant results have yet been obtained.

Pineapple plant material was used in these experiments, since in Hawaiian pineapple fields at the end of three to four years' growth, the amount of plant material to be disposed of prior to replanting frequently exceeds 100 tons and sometimes 150 tons per acre. Current practices involve decomposition of this material in place, chiefly on the soil surface, with gradual incorporation into the soil. The effects of this field handling and of more prompt plowing under upon nematodes are still undetermined.

Corresponding results follow decomposition of other plant materials. For example, data not included in Table I were obtained in Experiment 1 following the application of grass (*Panicum barbinode*) at a rate equivalent to 165 tons per acre-foot. This excessive application was for comparison with approximately equal dry matter in 200 tons pineapple per acre. The check was the same as shown in Table I, Experiment 1, with 611 ± 46.5 *H. marioni* galls per jar of soil. After decomposition of grass, the gall count was 16.5 ± 2.9. This reduction, though not quite equal to that obtained with pineapple in this experiment, still has enormous statistical significance.

The mechanism of stimulated activity of natural enemies of nematodes reported here may have been a factor in the beneficial results attributed by various investigators to green manures on Heterodera-infested soils, for this mechanism may be expected to reduce soil populations of obligate plant-parasitic nematode larvae generally where effective nema-destroying fungi occur and where sufficient organic matter is incorporated into the soil to build up a heavy population of free-living nematodes.

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[8] S. R. Miles, *Jour. Amer. Soc. Agron.*, 26: 341–346, 1934.