THE INFLUENCE OF DIFFERENT HOST PLANTS ON SIZE AND PROPORTIONS OF THE BODY OF THE STRAWBERRY DITYLENCHID

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A morphometric investigation of females and males of the strawberry ditylenchus from 26 species of artificially infected plants, showed weaker development of gonads in individuals from the more resistant species and a line of variability of characteristics in individuals, significant in range but uninterrupted, starting from the most damaged to the most stable species of plant-hosts. For this reason body sizes and proportions cannot serve for differentiation of the races of *Ditylenchus dipsaci*.

The body sizes and proportions as well as certain morphological characteristics of stem nematodes can be subject to significant changes under the influence of conditions of existence and first and foremost while residing in different plant-hosts. The less favorable one or another plant species is for the ditylenchid's residence and reproduction, the more profoundly these changes take place (Kir'yanova, 1951; 1951a; Goodey, 1952; Bingefors, 1957; Salentiny, 1957; Wu, 1960; Blake, 1962; Edwards, 1962; Sturhan, 1966; Thorne & Allen, 1962). Study of this type of change of ditylenchids cultivated on different plants could contribute to appraising the susceptibility of these or other plants to corresponding plant nematodes.

In this article are given the results of a study of the influence of plant-hosts on the body sizes and proportions and on several other characteristics of the strawberry ditylenchid. The goal of the work was the determination of the suitability of using possible changes of these indices in plant nematode specimens in various plants for an appraisal of their susceptibility to the parasite.

Material and Methods

The population of *Ditylenchus dipsaci* (Kühn, 1857) Filip'ev, 1936 was examined from strawberry plants at the plantation of the Horticultural Institute of Non-chernozem Region. The experiment was started August 26, 1964. Strawberry, buckwheat, garden pea, field pea, tomatoes, onion, kidney bean, sugar beet, broad beans, narrow-leafed lupin , potato, red clover, timothy, rye, oat, vetch, tansy, maize, sunflower, carrot, cucumbers, soy bean, asparagus, and French marigolds (*Tagetes patula*) were sowed or transplanted in 90 by 40 cm boxes with a mixture of soil in which the absence of *D. dipsaci* was established. Seed and planting material were tested for absence of ditylenchids by means of an analysis by the Voronoch method of samples chosen at random from lots prepared for the experiment. The solid mixture consisted of 1 part sand and 1 part local soil (heavy, well-cultivated loam, pH 6.8). The cultures being sowed were infected at the time of sowing by the introduction of strawberry ditylenchosis

galls with a known content of ditylenchids[1] and of water suspensions of ditylenchids at 3,000 ditylenchids per box. Potato tubers were infected with a mixture of galls placed in incisions close to the eyes, while those of the strawberry and phlox were infected with a mixture of galls at the growing points and by the introduction there of drops of ditylenchid suspensions at an overall rate of 50-70 ditylenchids per plant. A moist atmosphere was maintained around the plants for 4 days after inoculation by means of sprinkling them with water spray under covers of polyethylene film. The temperature during this period was 21-24°C by day and 10-12°C by night. Care of the plants assured by watering, soil cultivation, and weeding.

Analysis of the plants was carried out by the Voronoch method within 3 months after inoculation. The nematodes extracted were anaesthetized in water at 55-60°C, fixed in "TAF" and mounted in glycerin and water (1:16). In the case of sexually mature specimens, the indices were computed after measurements with the help of an ocular micrometer: de Man formula, V and T (Thorne, 1961), ratios of the lengths of anterior gonad and of the rudiment of the posterior gonad as a percentage of the overall body length (correspondingly G1 and G2), ratio of the length of the posterior uterus (in %) to the distance from the vulva to the anus (PUS/V-An.), ratio of the length of the tail from vulva to tip (An.-End/V-End), length of spicules, and length and location of end of bursa relative to tip of tail. The shape of the tail tip was also recorded. In all 362 females and 372 males from 26 species of plants were measured.

RESULTS AND DISCUSSION

Typical symptoms of ditylenchosis were observed within 3 weeks after inoculation in the above-soil parts of strawberry, buckwheat, pea, potato, onion, sunflower, cucumbers, tomatoes, sugar beet, alfalfa, asparagus, French marigold and carrot plants. A lag in growth, swelling on the axial organs and crimping of the leaf plates were noted in young broad bean and narrow-leafed lupin plants, but with maturity they gradually disappeared. No sign of disease were observed in the remaining cultures. Sexually mature specimens were extracted from all plants with the exception of cabbage and clover[2].

The results of the morphometric study are given in Fig. 1-3. The composition of the ditylenchid populations extracted from different plants was not identical. In those of the strawberry, buckwheat, garden pea, kidney bean and alfalfa it was very easy to gather up to 25 specimens of both sexes for research. In extractions from the remaining plants it was necessary to choose

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[1] The ditylenchid content in strawberry galls was established at 1 gram of plant mass by means of analysis of ten 5 gram samples, taken at random from a carefully shuffled batch of galls.

[2] Shoots of the red clover were cut up, and only a few plants were preserved to the moment of analysis, which could have an effect on results of the experiment. The red clover usually supports propagation of the strawberry ditylenchid.

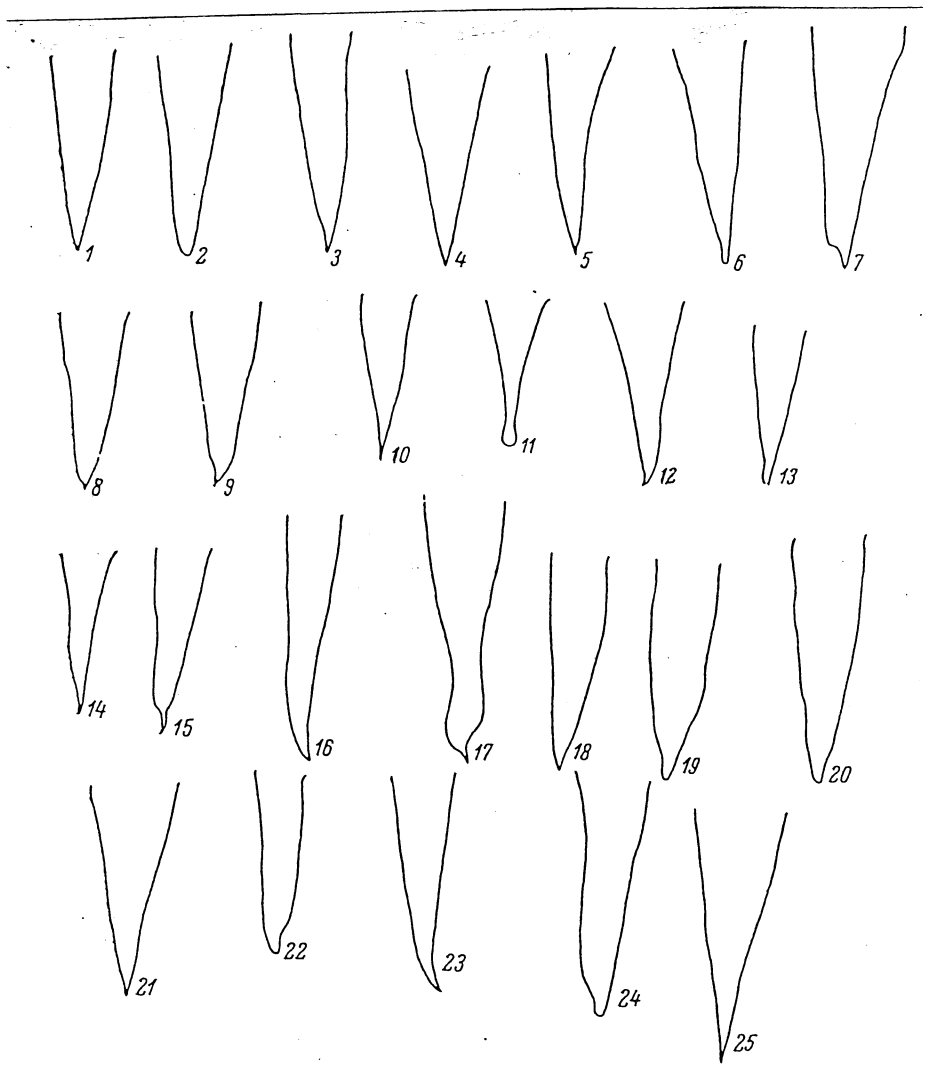

Fig. 1. Variations of shape of tip in specimens of the strawberry ditylenchus, extracted from different plant-hosts.

Specimens from: 1,2: ♂♂ of carrot; 3-5: ♂♂ of tansy; 6: ♂ of potato; 7: ♀ of potato; 8,9 ♂♂ of alfalfa; 10-13: ♀♀ of alfalfa; 14,15: ♀♀ of vetch; 16: ♂ of vetch; 17: ♀ of broad beans; 18,19: ♀♀ of tomatoes; 20: ♀ of narrow-leafed lupin; 21,22: ♂♂ of buckwheat; 23: ♀ of buckwheat; 24: ♀ of field pea; 25: ♀ of strawberry (1, 21 and 32 conform to the shape of tail normal for *Ditylenchus dipsaci*; the rest are aberrant).

all sexually mature individuals that were available; for example, in extractions from the oat plants there were only 5 females and 7 males out of about 250 ditylenchids.

With respect to the characteristics studied we did not on the whole succeed in discovering significant differences among specimens of the strawberry ditylenchid extracted from different plant-hosts. Females and males from the

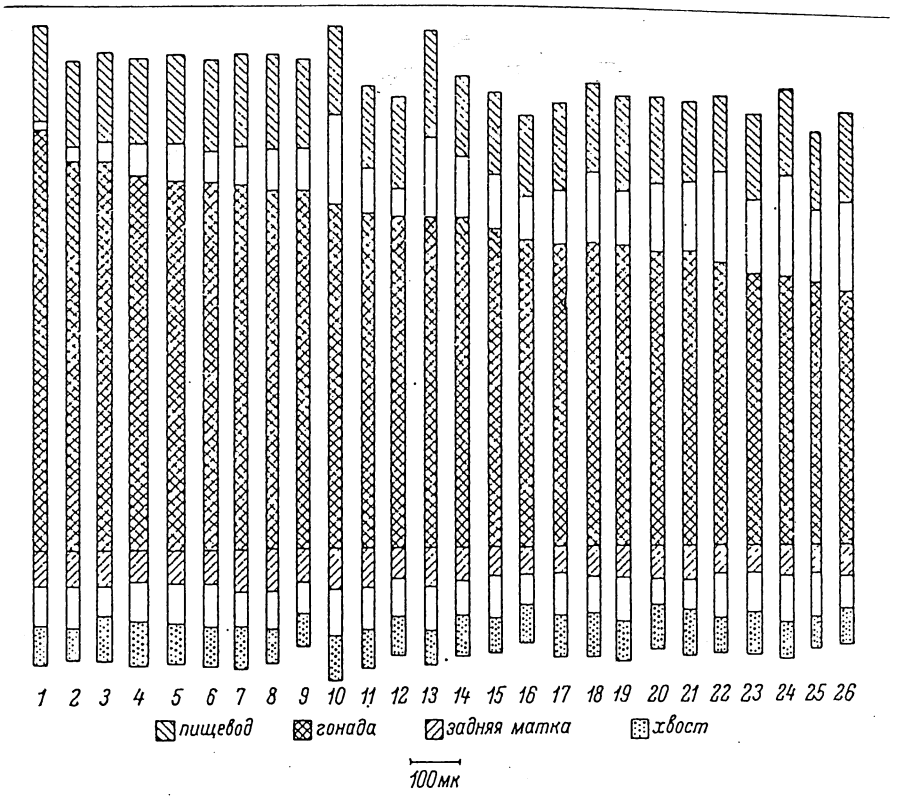

Fig. 2. Influence of different plant-hosts on the average body dimensions and proportions of strawberry ditylenchid females extracted from them.

Specimens from: 1: strawberry; 2: buckwheat; 3: sugar beet; 4: alfalfa: 5: carrot; 6: garden pea; 7: cucumbers; 8: potato; 9: onion; 10: kidney bean; 11: 12: tomatoes; 13: asparagus; 14: timothy; 15: soybean; 16: parsley; 17: field pea; 18: broad beans; 19: narrow-leafed lupin; 20: French marigold; 21: tansy; 22: rye; 23: vetch; 24: oat; 25: maize; and 26: mustard.

Note: The four shaded boxes read in order: oesophagus, gonad, posterior uterus, tail, bar = 100 μm.

strawberry possessed the longest body length (on average respectively 1110.5 and 1383.2 μm), while females from maize, (1118.9 μm) and males from the mustard (1072.9 μm), have the shortest. In absolute values the shortest were a female from the tansy (1037.4 μm) and a male from maize (970.9 μm), while the longest was a female from the kidney bean (1609.3 μm) and a male from the strawberry (1502.9 μm). The greatest body width was observed in a female from the potato and alfalfa (respectively 39.8 and 39.5 μm), while the smallest was in a female from maize (23.1 μm). The widest were males from the potato (34.9 μm), the narrowest were males from the tansy (24.7 μm). The maximum body diameter in females was usually situated at the level of the anterior uterus, especially if

there were eggs there. Maturing oocytes and eggs were not seen in the gonads of females from maize, tansy, mustard, oat and vetch, and the diameter of the body was maximal at the vulva. In females from the oat undoubted signs of degeneration were observed; they were unusually narrow (in the middle of the body their width equaled 20.3 μm), while the vagina protruded significantly above the level of the body, and the diameter on its level was equal on the average to 30.8 μm.

The average index a (the relationship of body length to its width) varied from 35.2 in females from alfalfa to 48.7 in females from asparagus; in absolute value it was equal to 28.2 in one of the females from buckwheat while in one of the females from maize it was 53.4; in males index a of the kidney bean was highest (51.8 on average, maximum 59.9) while the lowest was in males of the potato (34.8 on average, minimum 27.9).

The index b varied within very narrow limits in both sexes from 6.2 to 7.1 by average values in females and from 6.1 to 7.2 respectively in males. The index c also changed insignificantly: 14.0-18.9 by average values in females and from 13.3 to 17.9 respectively in males, which points to changes in the length of esophagus and tail, proportionate to changes in body length.

In specimens of the oat, vetch, maize and mustard a significant part of the mid-intestine was devoid of any kind of granulation, apparently because of starvation. The occurrence of deformities of the tip of the tail (Fig. 1) increased with the lessening of the susceptibility of the plant-host. Out of 25 males and 25 females analyzed from strawberry and buckwheat plants, only about 1 specimen of each sex was seen with variation of the shape of the tip; while from the same quantity of ditylenchids from alfalfa up to 2 specimens had an altered shape of the tip; in ditylenchids from the vetch aberrations of the tip were observed in 3 out of 10 specimens of each sex; and in the tansy 3 females out of 6 and 2 males out of 7 had such aberrations. Changes in the shape of the tip were parallel in specimens from different plant-hosts, and blunt tail tip was often observed.

The position of the vulva was relatively stable. The mean values of index V was maximal (82%) in females from the strawberry and sugar beet, and minimal (78.7%) in females from the oat. In absolute values it varied from 75 (female from the oat) to 85.6% (female from the kidney bean).

The mean values of index G1 (length of anterior gonad (in %) to length of body) varied from 65.1% in specimens from the buckwheat to 48.1% in specimens from the mustard. In absolute values, it varied from 71.8 (female from the garden pea) to 42.0% (female from rye).

The mean values of index T in males (length of gonad (in %) to length of body) varied from 71.6 (specimens from the buckwheat) to 45.5% (in specimens from the oat). In absolute values, variations were from 81.7% (♂ from the buckwheat) to 37.2% (♂ from the oat).

Differences in absolute lengths of the gonads were even sharper. Since apparently these lengths to a certain extent can point to the sexual productivity of specimens we took this index as a basic one in comparing ditylenchids from

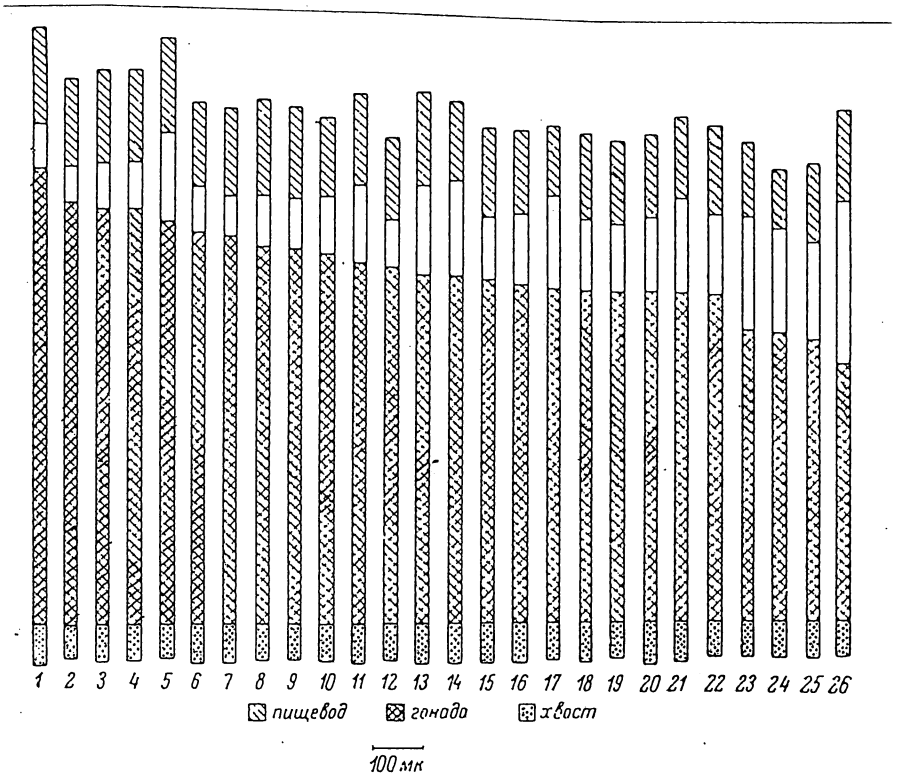

Fig. 3. Influence of different plant-hosts on the average body dimensions and proportions of strawberry ditylenchid males extracted from them.

Specimens from: 1: strawberry; 2: buckwheat; 3: cucumbers; 4: garden pea; 3: kidney bean; 6: sugar beet; 7: alfalfa; 8: potato; 9: carrot; 10: onion; 11: field pea; 12: soybean; 13: asparagus; 14: timothy; 15: tomatoes; 16: sunflower; 17: narrow-leafed lupin; 18: French marigold; 19: parsley; 20: tansy; 21: broad beans; 22: vetch; 23: rye; 24: maize; 23: mustard; 26: oat.

Note: The three shaded boxes read in order: oesophagus, gonad, tail, bar = 100 μm

different hosts in Fig. 2 and 3. The average length of gonads in females from the strawberry was the largest and exceeded that of females from the mustard (the smallest) by 1.7 times; the average length of gonads in males from the strawberry was higher that of males from the oat by 1.8 times. The lower section of well developed gonads in specimens from the strawberry and buckwheat occupied a large section of the body cavity. In specimens from the oat and mustard the gonads were narrow in their lower part, occupying less than 1/2 the diameter of the body cavity. Narrow gonads that occupied in their lower part slightly more than half the diameter were observed also in specimens from soybean, broad beans and tansy. In the anterior uterus of one female from the broad beans there were simultaneously 2 small eggs 21.5 μm in width instead of 36.3 μm of corresponding body diameter (in usual instances the eggs occupy 88-91% of the body cavity).

Correspondence between measurements of the body and length of the gonads was not always observed. Both females and males of the kidney bean yield very little in length and width to those of the strawberry, but their gonads were shorter than those, not only of the strawberry specimens, but also of the specimens with smaller measurements from the buckwheat, garden pea, potato, alfalfa, onion, carrot and sugar beet. Specimens of the mustard and parsley were approximately of identical length, but the gonads in specimens from the mustard were significantly more poorly developed.

The relative length of the posterior uterus in females of the strawberry ditylenchid from different hosts fluctuated in average values from 51.3% (in specimens from the potato) to 34.6% (in specimens from the oat), but in absolute values from 76.0% (♀ from the kidney bean) to 24.3% (♀ from the oat). The relationship of the length of the tail to the distance from vulva to anus varied in average from 32.1% for females from the field pea to 39.2% in females from the vetch.

The position of the bursa relative to the length of the tail varied in average values from 73.2% in males from the soybean to 62% in males from the field pea, while in absolute values from 83.2% (♂ from the buckwheat to 50.0% (♂ from the sunflower). Sizes of the spicules in males varied little in average values: from 21.1 μm (males from the maize) to 24.1 μm (males from the garden pea). However, with males extracted from the oat, the spicules on the average were equal to 26.2 μm, and they were longer than in males extracted from other species of plants. Changes in the length of spicules in males of *Rhabditis* spp. in different culture media have already been noted (Goodey, 1952); therefore there are no bases for reassessing the taxonomic significance of this index.

Results obtained are preliminary: only a small quantity of ditylenchids from each plant have been studied. The method of research itself is in need of revision. It is unclear for the moment how long the ditylenchids should feed on the species of plants being tested. Specifically, the duration of the cycle of development of *Ditylenchus dipsaci* increases in resistant oat cultures (Blake, 1962) and it is necessary to regulate the composition of the inoculum, removing sexually mature specimens from it, since the latter can survive in plants 2-3 months (Hodson, 1931). It is therefore desirable to cultivate plant nematodes in annual plants over a period of 3-4 consecutive generations, and in perennials, not less than 1.5-1 years, as this was carried out by Van Slogteren (1934) in his work with hyacinths and narcissi. For these purposes it is necessary to devise methods of rapid inoculation of plants by minimal quantities, sometimes even by unique specimens, of ditylenchids.

Despite the preliminary character of the data obtained it seems possible to draw several conclusions. To begin with, the level of development of strawberry ditylenchid specimens, and of their gonads in the first place, depends on how susceptible to the plant nematode is the species of plant infected by it Specimens of strawberry ditylenchid from susceptible buckwheat (Metlitskii, 1966) had significantly better developed gonads than specimens from oats, mustard and maize that were not displaying characteristics of infection and were virtually resistant. Second, there were apparently no sharp boundaries in levels of strawberry ditylenchid population in species of plants different in their susceptibility. We observed an uninterrupted series of changes in morphometric

indices of the plant nematode from specimens from the strawberry and buckwheat that are the most favorable for it, to specimens from the oat, maize and mustard that are practically resistant to the parasite. It is possible that this is connected with only the initial differentiation of a relatively polyphagous strawberry race of stem nematodes, and that polyphagy in stem nematodes is primary and oligophagy is secondary (Metlitskii, 1966).

Third, the variations observed in the characteristics studied point to little suitability of these indices for taxonomic differentiation of stem nematodes. This in particular confirms the groundlessness of allocating the strawberry ditylenchid to a separate species *Ditylenchus fragariae* Kir'yanova, 1951 based on differences in measurements from stem nematodes of the onion and phlox (Metlitskii, 1967).

Our data in many respects recall the results of Kir'yanova (1951a) according to her study of a range of plant-hosts of the stem nematode of the onion. She also observed variations in measurements of the body, shape of the terminus and a series of other indices in ditylenchids extracted from different plants. It seems to us, however, that her conclusion, that the very short (less than 1 mm in length) ditylenchids with a very sharp tail that she observed from cucumbers, beets, oats, wheat, millet and alfalfa were other species of stem nematodes, was erroneous. Apparently these "species" were nothing but forms of onion ditylenchid, that were changed under the influence of conditions of living in plants resistant by it. By this example I would like to underscore that morphological changes of ditylenchids under the influence of plant-hosts are modifications and therefore cannot have taxonomic significance.

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English Summary

362 females and 372 males of *Ditylenchus dipsaci* from 26 species of artificially infested plants were morphometrically studied. It was found that most poorly developed were gonads of individuals from most resistant species of plants. It was observed a continuous row of variability of all characters of *D. dipsaci* from most injured plants (strawberry, polygonum) and practically resistant species (oat, mustard, maize). The amplitude of fluctuations of indices between extreme values was, however, significant. Due to such a variability size and proportions of the body cannot play a decisive role in distinguishing races of *D. dipsaci*.