PRELIMINARY STUDIES ON A MARYLAND GINSENG POPULATION

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Introduction

October 16, 1978 several of us* harvested above-ground parts of 740 American ginseng plants (*Panax quinquefolius*) from near Washington, D.C. (annual precipitation ca 10 dm; annual temperature ca 12°C). Most of the leaves had already yellowed, so we assumed we would not hurt the population by harvesting the above-ground parts this late in the season. Actually, removing these leaves lowered, significantly, the probability that unscrupulous collectors might be tempted to harvest the roots. Our objectives were to (1) submit material to the cancer screening program of the National Cancer Institute (NCI), and (2) study the structure of the population. When commercial development threatened the population in the summer of 1979, (3) transplant experiments were attempted, and (4) biological observations were made on the transplants periodically.

Results

Cancer Screening

According to M. Suffness (personal communication, 1980), the samples submitted to the NCI cancer screen were negative for P388 leukemia and not cytotoxic to the KB cell line (inactive and nontoxic up to 400 mg/kg). Three hundred mg of stem, leaf, and inflorescence, collected October 1978, were extracted with 95% reagent alcohol using a 3.5- gallon capacity percolator. The solubles were concentrated to paste in vacuo and partitioned between chloroform and water (the latter discarded). The chloroform partition was concentrated in vacuo and oven dried in vacuo to constitute the test sample.

In the P388 test procedure, 10^6 cells of P388 leukemia line were injected into mice on Day Zero. Treatment with extract was begun on day 1 at doses indicated, and continued for 9 days with one injection per day. The median life span of the treated mice was calculated and divided by the median life span of the tumored but untreated controls and multiplied by 100 to get a % T/C (Test/Control). An increase in life span of 30% is considered active (T/C $\geq$ 130). The values for the ginseng extract were right around 100 indicating that the extract had no effect on life span.

Population Structure

Of the 740 plants, 37 were "one-prongers" (with

* Dr. R. Broome, Dr. J. Duke, Ms. P. Duke, Ms. C. Hoynes, Dr. D. Hoynes, Mr. D. Reveal, Dr. J. Reveal, and Ms. K. Wain. My thanks are extended to these collaborators.

Table 1. Frequency of leaflet counts

No. Leaflets	No. Individuals
3	29
4	5
5	3
6	12
7	6
8	21
9	32
10	57
11	0
No. Leaflets	No. Individuals
12	2
13	12
14	26
15	377
16	4
17	1
18	6
19	7
20	122
21	13
22	3
23	1
24	0
25	1

one compound leaf), 128 were "two-prongers", 422 were "three-prongers", 152 were "four-prongers", and 1 was a "five-pronger". Twenty nine had a total of 3 leaflets, 57 had 10, 377 had 15, 122 had 20, and 1 had 25 leaflets. The frequency of total leaflet counts is tabulated above.

Peduncles on three-prongers averaged 5 cm (2.5–8.0 cm) while petioles averaged 10 cm (8–12 cm). Peduncles on four-prongers averaged 8 cm (4–13 cm), while petioles averaged 12.5 cm (10.5–14.5 cm).

Three-prongers had 1–4 major branches of the roots (average 1.6) averaging 5.7 cm long, while four-prongers had 1.4 major branches of the roots (average 2.2), averaging 7.8 cm long. Live weights of nine roots averaged 13.5 g each. Three-prongers had crowns averaging 27.5 cm in diameter, 26.2 cm tall. Four-prongers had crowns averaging 39.8 cm in diameter, 36.8 cm tall.

Transplant Experiment

On July 4, 1979, following a warning that the population might be damaged or destroyed, 300 of the specimens were dug, transported about 15 miles, and replanted in Fulton, Maryland, under a canopy composed largely of *Juglans, Liquidambar,* and *Robinia.* Fortunately, it was a cloudy humid day, so the plants were not too badly desiccated in transit.

No significant differences appeared between transplants that were:

(1) planted at their original depth, or 2-1/2 or 5 cm deeper

(2) staked or unstaked

(3) three-prong or four-prong

(4) decapitated or whole

Of course, those few which were transplanted with their root balls intact survived better than bare root specimens.

There is probably no worse month than July for transplanting ginseng in Maryland. By September 1, it appeared that 90% of the transplants had died, at least above ground.

However, by the summer of 1980, it was clear that more than 65% had survived the first year of transplant, even though many had fewer total leaflets than they had had before transplant. All the living plants are labelled so that their development and/or mortality can be observed over the next few years. Apparently, disease has taken a bigger toll than transplant. Mortality is also suspected to have resulted from falling limbs (at least two specimens), digging animals (at least two specimens), careless weeding (at least two specimens), and browsing goats (at least one specimen).

Biological Observation

Pollinating Agents: Less than one month following transplant, two insect visitors were observed rather regularly on the flowers, *Dialictus* sp., (determined S.W.T. Batra, Insect Identification and Beneficial Insect Introduction Institute, IIBIII, USDA, Beltsville, Maryland), and *Toxomerus geminatus* (Say) (determined F.C.Thompson, IIBIII). Both are suspected of pollinating the ginseng as well as other species. Pollen collections are clearly visible on the legs of several of the foraging *Dialictus.*

Virus: A serious disease has shown up in

the transplant population as well as in material derived from the trade. USDA mycologists and ematologists ruled out fungi and nematodes as causative agents. Symptoms include a yellowing and/or contortion of the leaves, followed by rapid decline. Some specimens die within two weeks, others (perhaps more valuable germplasm) survive. Dr. H. Hsu, of the American Type Culture Collection speculates that the virus might be closely related to the Potato Yellow-Dwarf Virus, if in fact, it is a virus. Dr. Hsu recently heard of a rhabdo virus (rod shaped) from Wisconsin ginseng, which proved to be morphologically and serologically identical with Potato Yellow-Dwarf Virus. Dr. Hsu has agreed to see if he can isolate similar particles from symptomatic specimens of the Maryland Ginseng population.

Insect Pests: By late June of 1980, most of the transplants had the peduncles (but not the petioles) coated with a halo of cottony insect juveniles. Adults of two species were obtained from the ginseng, *Ormenoides Venusta* (Melichor) of the family Flatidae and *Acanalonia conica* (Say) of the family Acanaloniidae. (Determination by J. Kramer, IIBIII.) Juveniles and adults are plant feeders and could possibly be vectors of the virus.

Aphids of the species *Aphis gossypii* (Glover) were isolated from the inflorescences and identified by M. Stoetzel, IIBIII. Larvae of three Lepidopterous species were found in deformed leaves. At least one of them was cutting the petioles and at least one was rolling the leaves or causing the leaves to roll. The lepidopterous material has been turned over to D. Weisman, IIBIII.

Conclusions

With more than 65% surviving for more than one year, after a midsummer transplant, our study population is being killed off by falling limbs, burrowing animals, grazing animals, insects, and most importantly, what appears to be a virus disease. It looks as though the population will mature seeds numbering more than ten times the number of plants lost this year.

Chairman: Now the time is open to discussion.

Proctor: Let me first thank you for the very interesting presentation. One of the questions I have is when you transplant your ginseng plants to pots? Have you noticed any marginal scorching or other injury in the growth chambers?

Duke: I have not, but a friend, Dr. John Ambler, formerly with the plant stress laboratory was growing not in a potting medium but in a liquid culture medium. And he got somewhat yellowing of the margins. Certainly when I had it out open in the sun, I've got yellowing of the margin also. But there's more to what's happening with my woodland population we are getting a contortion that looks very much like virus. So far the nematologists have disowned this disease, the microbiologist disowned it they can find a fungus. The virologists thought that it was going to be a virus just same with Wisconsin material. But when I gave the diseased material he was unable to indentify the viro particles. So at this moment I have a serious problem and I don't even know what my problem is. We are finding where we attempt to grow plants in growth chambers. We get the stippling on the leaves. We are carrying a parallel study in which we are exposing plants to ambient pollutants such as ozone and sulfadioxide. And we think that the plant which are grown in the growth chamber are exhibiting and calling it a growth chamber injury effect. This is stippling that looks a little like ozone injury, but it is not ozone injury. From our pollution studies we are finding that the plants preliminary studies of the American ginseng is very resistant to ozone and sulfadioxide. Both populations that I studied are original population or transplanted population are fairly well removed from the pollution of Washington D.C. It is surprising that 20 miles from there we are in the green belt as they call them. Let me say that you are fortunate, our growing area is an area which is renowned for ozone injury particularly to tobacco.

Questioner: Thank you for your very impressive

presentation. I'd like to ask you. Are there any difference between the wild American Panax and the cultivated one? I mean the roots and leaves.

Duke: I have very many other people comments on this. Certainly the price of the economic price paid for the wild material is always 2 to 3 times as high as I understand pay for the cultivated. It seems to me that those growth in the wild has a much more difficult time and tends to be more resembles the man that is so much appreciated by some purchasers of ginseng. That grown in good condition has a bigger roots so far as my observations go. The more of that root is water and less of ginsenosides. I am no chemical analyst. I am speculating on that.