John N. Kallas
510 Boreal Flora
August 9, 1981

Aralia nudicaulis

[redacted] the North Shore [redacted], Members of that [redacted]

good — marred by pathological spelling. Distinction between root & rhizome is not at all clear!

Purpose

The Purpose of this paper is to present data, ideas, and speculation involving the description, life history and major ecological relationships of Aralia nudicaulis. (Abv. ANUD)

Introduction

Much naive observation was done in preparation for this paper. Many good potential natural experiments passed this researcher by as the season progressed. Hindsight makes one a great experimenter later. Observation and experimentation that was done would not pass for good scientific research. Control groups were not practical in this instance. Sample size and selection were affected by what fruits were available when I arrived on the scene. I have no idea what was there before I arrived. My thoughts and observations were many, as I tried to observe many aspects of ANUD to obtain an overall picture. There will be no separate methods, materials and results section as I have incorporated what I have learned throughout the paper.

Nomenclature & Taxonomy

According to Fernald (1950, p1077), Aralia is a small genus of the North American continent. Members of that genus are also found in Asia and Australia. Original specimens were apparently sent to Tournefort by a Quebec physician Sarrasin under the name of 'Aralie'. Blakiston (1949, p. 88) suggests that Aralia is probably Iroquoian in origin.

ANUD is most commonly referred to as 'wild sarsaparilla'. Other common names used to refer to similar members of the Aralia genus are Salse pareille (ANUD), Spikenard, American Spikenard, Petty-morrel, Life-of-man (A. racemosa), Bristly Sarsaparilla, Dwarf-elder (A. hispida), Spignet and Spiceberry. (Fernald, 1950, p. 1077, Merck, 1960, p. 96 and Peterson, 1968, p. 50)

The Araliaceae is closely associated taxonomically to the Apiaceae (Umbelliferae) and the Cornaceae through the Order Apiales (Umbellales). In the Apiales, the flowers are small, epigynous and without a hypanthium. Two to five carpels are fused into one pistil. There are as many

stamens as petals. Stamens and petals are alternately arranged. Cornaceae differs from the other two in that its flowers are generally 4 merous with a single style. The leaves are simple and usually opposite. The Apiaceae and the Araliaceae both have 5 merous flowers and compound leaves (rarely simple), that are alternate or basal. They differ in that the Araliaceae have 5 styles, with a berry or a drupe fruit. The Apiaceae have 2 styles and the fruit is a schizocarp.

The genus Aralia is different from Panax, Oplopanax and Hedera in that it has 2 to 3X compound leaves and 2 or more umbels. The other members of the Araliaceae have either simple leaves or solitary umbels.

ANUD differs from theother species (A. hispida, A. racemosa and A. spinosa) of Aralia in that it has unarmed herbaceous stems with leafless peduncles arising directly from the rhizome. The other species have woody or leafy stems which may be armed.

As far as I can find, there is no dispute over the taxonomy of ANUD. Fernald (1950, p. 1077) mentions a Forma virescens Vict. & Rousseau that apparently is 'greenish' and has 'carpels changed to leaves'. He gives no clarification beyond that.

Description

ANUD is a clonal perennial herb. A single plant of a clone consists of 1 (2-3) leaves and a single flower stalk with 3 (2-7) umbels containing about 50 flowers apiece. Both leaf petioles and flower stalk originate directly from the rhizome, which may actually be short stem shoots. The leaf is 2 to 4 dm high (rarely 5) and umbrella-like in overall appearance. The naked peduncle (scape) is shorter then the petiole and often hidden from above by the leaf. Each leaf is ternate. Each division is pinnately 3-5 foliate. Leaflets are lance-elliptic to oval to oblong to obovate. They are acuminate tipped, coarsely serrate and the lateral ones are asymmetrical at the base. The flowers are "primarily dioecious with less then 1% hermaphroditic reproductive shoots". (Edwards, Joan) It is primarily the older shoots that become perfect (Edwards, 1981). The petals are small and greenish-white, the calyx is much reduced. Petals and stamens are 5. Flowers

are regular. Carpels are 5 (4-6) with one anatropous, pedulous ovule per cell. Styles are free and spreading. The flower is epigynous. The ripe fruit is nearly a black berry, with persistent styles and 1-6 hard seeds within. There is a small stem, if one wishes to distinguish it from the rhizome, that could be 1 to 30mm long. The rhizome is thickened towards the base of the plant where leaf scars remain. The age of the plant can be estimated from the scars (See Appendix). These rhizomes run somewhat horizontal to the ground and connect to other plants of the clone by thinner rhizomatous underground runners.

My personal observations are consistent with this description except for the extremes (Edwards, Joan). I saw no more then two leaves on any single plant. Numbers of umbels ranged from 3-5. I saw no perfect flowers. Male flowers were difficult to locate as it was past their season. All apparent male inflorescences collected appeared, in fact, to be females. Dissection revealed locules and ovules. Microscopic examination of undeveloped assumed males may be necessary to determine that they are not underdeveloped females. I examined flowers from 3 assumed males collected by a plant ecology class at the University of Michigan Biological Station (UMBS), Pellston, Michigan. All had locules and some had ovules. They had dried naturally on the stalk and had undergone no developmental expansion.

Habitat, Plant Communities and Associations

ANUD will grow in both moist and dry ground that is flat or sloped. It thrives on hummocks in moist soils. I have seen no real preference for any side of a slope, though I have not seen it growing in ground with angles greater then 45 degrees. This was seen with non-fruiting plants at Tahquamenon Falls, Michigan on July 2, 1981. I have not seen ANUD in disturbed ground, weed communities nor in the open full sun. It will grow, however, in clear-cut openings for power lines between wooded areas. I don't know what the long term fate of these strong sun plants is. Polly Fairchild (1981) has data to the effect that plants in power-cuts were fruiting significantly heavier then those in the adjacent woods. Curtis (1959, p. 333)

determined the average frequency of ANUD in quadrats within an oak forest in relation to the amount of light available. He found no plants growing in the open full sun (10,000 + foot candles). He found an average of 17 plants growing where they were not shadded during midday sun (1,000 to 10,000 foot candles) and 36 growing beneath a canopy (0 to 1,000 foot candles).

According to Curtis' Vegetation of Wisconsin (1959), the native community in which ANUD achieved its maximum presence was a Northern Dry-Mesic Forest. ANUD was found in 95% of all boreal stands examined and 53% of the total communities they observed in the state. Table 1 shows the presence and the average frequency that ANUD was found in different plant communities.

The ground cover plants found growing with ANUD are numerous due to its ability to grow in many different shadded communities. I have most often seen it with Maianthemum canadense, Cornus canadensis and Clintonia borealis. Less so, but still often, I have seen it with Mitella nuda, Trientalis borealis, Pteridium aquilinum and Rubus pubescens. Curtis lists these and many others. It seems that the woody species providing the canopy are not as important as the shade provided. It almost seems that, as long as there is shade, a northern (boreal) latitude or high altitude, there will be ANUD.

Range

The range of ANUD is limited to the North American continent. It extends from the northern tree-line of Canada down to about the 40th latitude where there are trees. It extends further south where there are mountain ranges to increase the altitude. South to Georgia in the east and Colorado in the west. (See Figure 1) ANUD is "one of the most frequent and abundant plants of the mixed deciduous-coniferous forests of well drained sites throughout the Clay Belt". (Baldwin, 1958, p. 203)

Life History

Germination

It may be that seeds of ANUD may need some type of scarification before they can germinate. This has been demonstrated for Aralia

racemosa (McGraw-Hill, 1966, p. 146a). This would be logical as the fruit is sweet, fleshy and conveniently clumped in umbels for consumption.

Growth and Fidelity

To thrive, it appears that ANUD needs shaded, cool (northern or high altitude) conditions in dry or well drained wet sites. It needs to be relatively free of predators until its rhizomatous system can support some herbivory (Edwards, Joan).

Reproduction

Sexual: Reproductive stalks are said not to form until the plant is 5 years or older. (Edwards, 1981) My own data reflects a much shorter time span, depending on how the growth rings are counted. See Appendix. An overall average, accounting for both conservative and liberal estimates gave a figure of 6.71 years for the fruiting specimens of my sample (N=19). With a standard deviation of 4.75 years, this means that 66.7% of all fruiting plants that I analyzed ranged from 1.96 years to 11.46 years. Thirty-one percent of my sample was below 5 years of age.

Fruiting stalks develop flowers on separate male and female plants. It is my guess that all plants in one clone are of the same sex, although this remains to be verified. This assumption comes from the fact that whenever I saw fruits on one plant, I would also see fruits on several adjacent plants. I have walked by many plants (sterile) with no fruiting stalk, then, I would come upon several square yards of fruiting plants. The problem here of course is that different clones can grow interspaced in the same area. Also the existance of hermaphrodites on any plants at all may indicate that different sexed plants are possible on the same clone genetically and physiologically.

ANUD flowers are small, packed in umbels and greenish-white. They are positioned on peduncles 1 to 2.5 dm tall. These conditions are well utilized by low flying insects like small flies. They visit small whitish flowers that are close to the ground (Melanchamp, 1981). According to Melanchamp, many white-flowered Apiacious plants are pollenated by flys. Their flowers are very similar to those in the Araliaceae.

Pollenation appears not to be very successful as many ovaries are not

fertilized fully and many mature fruits have less then 5 viable seeds. This may partially be a function of age, as the most number of mature seeds were found in plants between 11 and 12 years of age. This was out of 168 female shoots observed. Of those 10 plants that made up this most successful group there was an average of 77 seeds per shoot. Each shoot, on the average, contained 3 umbels, each umbel contained about 50 flowers and each flower contained about 5 carpels. So with an average of only 77 seeds per shoot and a possibility of 750 total viable seeds (3x50x5= 750), only 1% of the seeds that could have been there, were there. These are very rough figures as the 3, the 50 and the 5 are guestimates, based on my personal experiences and were never actually recorded in this experiment. Even so, with great error, the number of viable seeds would be small; less then 5%.

There may also be attractant variables that affect fertilization potential through increased insect activity around the flowers. Perhaps this 'optimal' age group produces the most potent pollinator attractants.

Asexual: ANUD appears to primarily reproduce by cloning. I have dug up probably over 200 plants in the last two years to use the roots for tea or to study female fruiting plants. Not once have I come across a seedling or even a non-rhizomatous plant. My needs, however, do preclude me from picking the younger plants. Joan Edwards in her unpublished study found that the mean distance between the nearest shoots of the same clone by direct connection was 1.48m. The mean distance between the nearest shoots of the same clone, connected directly or not, was0.52m. The mean distance between the nearest neighbors was 0.18m. This represents alot of interspersed growth and that clones may naturally give themselves more space perhaps for some adaptive reason. Cloning may be a protective strategy against herbivory and/or poor seed production/germination.

Seed Dispersal

Fruits that mature on the stalk that do not get eaten, eventually fall to the ground and the pulp disintegrates. Most fruits, at least those in the UMBS area get eaten by small animals, some even before they ripen. No ANUD fruits that I observed in camp survived more then two days of

ripeness. Local fruit was gone so fast! It was very frustrating. All the local fruits were eaten before I could set up a good observational situation.

Frugivery may be a very important seed dispersal mechanism for ANUD because of the possible need for scarification. Digestion would serve this purpose and possibly allow ANUD seeds to germinate. Fruiting stalk remains suggest that a variety of predators eat the fruits of ANUD. Some predators carefully pluck off each fruit, leaving the pedicels intact. Some predators bite off chunks of fruits taking parts of some of the pedicels with them. Some predators bite off whole individual umbels and some chomp off the whole inflorescense. I believe it is reasonable to assume that different sized animals feed on ANUD fruits and that some may be big enough so as not to have to chew the seeds.

Bird frugivery associated with ANUD includes the Pine Grosbeck (Pinicola enucleator) and the Red-bellied Woodpecker (Centurus carolinus) (Ridley, 1930, pp. 463&484). Other birds associated with the Aralia genus are band-tailed pigions, white-throated sparrows, olive-backed thrushes and wood thrushes (Martin, 1951, p. 348-9). Mammals known to have eaten ANUD fruits from scat studies are wolves and fox (Edwards, 1981). Martin et al (1951, p. 348-9), includes red fox and the eastern skunk as ANUD predators. Martin also includes a rodent, the eastern Chipmonk. ANUD feeding experiments were attempted with a captured local chipmonk. Under conditions of great hunger the monk would not consume any ANUD fruits.

On August 2, 1981, in Neys Park, Canada, Alrun Southwick, a student from the UMBS observed what she knew as a red squirrel eating an ANUD berry. The squirrel apparently ran up to the fruits, bent the peduncle to a 45 degree angle and pulled a berry off using both its paws and mouth. It then ran up a nearby tree and proceeded to eat the fruit. Seed crunching could be heard.

Twenty protective cages were devised to guard fruiting stalks from predation. In this way maturation could occur, and I could observe predation at my convenience. The size of the cage holes were 12 x 24mm so only insects could have entered unless underground tunneling had occured. The plot was near a dirt road in a well shaded wooded area.

Some direct sun was provided, however, by the roadway. When I wanted to observe frugivory, I would remove the cages and sit downwind about 35 to 40 feet waiting and watching with my camera focused on the plants. I observed no animals feeding on ANUD fruits. I observed no animals period. The site was absolutely desolate except for mosquitos. There were animals in the area as I later found out. Something had eaten the fruits of an umbel that had been sticking out the side of one of the cages, but this occured when I was not there to watch.

The cages also allowed me to assess insect damage to the ripe fruits. Evidently, in this area at least, insects play an insignificant role in fruit destruction. Only 1 berry out of 19 plants showed any sign of insect damage.

Human Related Issues

ANUD roots have long been used as an ingredient in root beer as well as a stock for tea. The root has been used for food by the New England area Indians during times of war or hunting expeditions. (Fernald, 1958, pp. 283-4, Peterson, 1978, p. 40). The root contains starch, pectin, sugar and resin. (Merck, 1960, p.96)

The dried rhizomes of ANUD contain a volitile oil and a saponin. The root was formerly used as a stimulant, a diaphoretic and an alternative. The dose was about 30 grams of the root. (Blakiston, 1949, p. 88) It was also formerly used to help treat rheumatic fever, syphilis and dermatosis. (Merck, 1960, p. 96)

The Chippewa Indians used ANUD root for several medicinal purposes. A decoction was made to treat "diseases of women". That is, to stop menstrual flow. The mashed roots were applied as a poultice to treat skin sores. The chewed roots were inserted in the nostrils to treat nasal hemorrhage. (Desmore, 1928, pp. 350-9)

While I could find no toxicological data on ANUD it would be wise to proceed with caution with regards to its use as food. To me, the berries are sweet, juicy and have a medicinal flavor. I observed no ill effects from eating a couple of berries (seeds were omitted). The medicinal uses of the roots, however, suggest that there may be pharmacological substances potentially harmful in large quantities, at least

rhizome is stem anatomically, not root — you seem to use the terms interchangeably

in some parts of the plant. The roots and seeds are typically locations of toxin storage and accumulation. Hardin and Arena (1974) make comments about species related to ANUD. They state that the fruits of Panax quinquifolia (ginseng) can be eaten raw, but that they are not good. My question is how much was eaten raw to determine they can be eaten raw. They suggest that Aralia spinosa (Hercules' club) has black berries that 'may' be poisonous if eaten in 'quantity'. (p. 107) They generalize about the genus Aralia. They say you can make jelly out of the berries of A. nudicaulis, A. racemosa and A. spinosa, but they are poisonous when raw. (p. 153)

Conclusion

Aralia nudicaulis is an interesting North American woodland plant. It is a clonal perennial plant that serves as a ground cover for many plant communities as long as they are shadded, northern and well drained. ANUD achieved its maximum presence in Northern Dry-Mesic Forests. Plants most often seen with it are Maianthemum canadense, Cornus canadensis and Clintonia borealis. It ranges from the tree-line of Canada, south to the mountain ranges of the southern United States. Its seeds may need to be scarified to germinate. It needs to grow several years before it can produce a fruiting stalk. Pollination is not very successful. Seeds are probably dispersed by animals that swallow the seeds whole. The roots have been used as an ingredient to make root beer and tea. The chewed roots were used to plug nose bleeds.

Figure 1

Range Map of Aralia nudicaulis

Based on verbal descriptions from Gleason & Cronquist & Gray's manual.

Table 1

Presence and Frequency of Aralia nudicaulis within its Major Plant Communities in Wisconsin

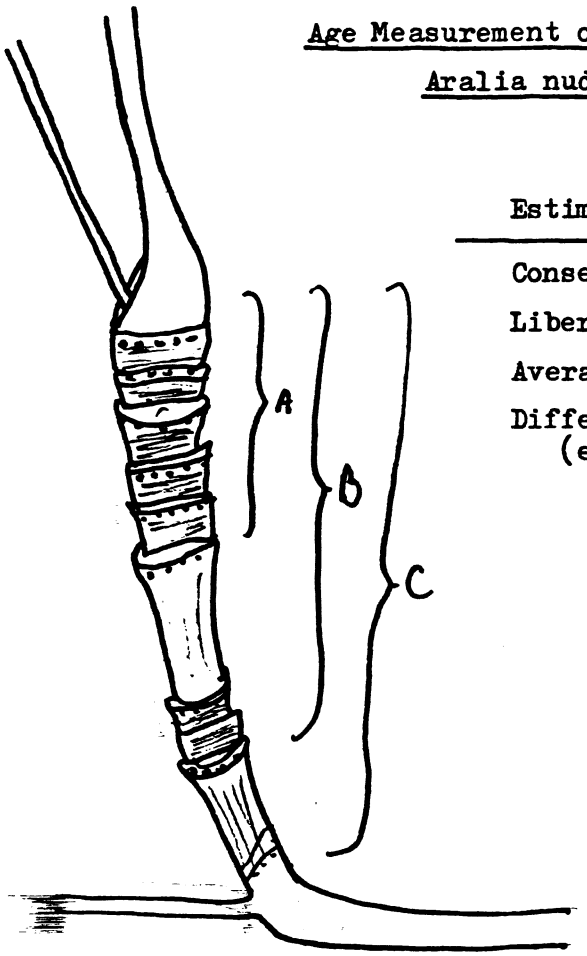
Plant Communities		Presence	Average Frequency
Northern Dry-Mesic Forest	*	98%	26.1%
Northern Wet-Mesic Forest	*	96%	20.5%
Boreal Forest	*	95%	31.2%
Northern Dry Forest		76%	14.1%
Southern Dry-Mesic Forest		76%	11.9%
Northern Mesic Forest	*	71%	11.9%
Southern Dry Forest		60%	10.1%
Shaded Rock Cliffs		64%	- - -
Average of All Communities Surveyed		53%	- - -

* Indicates that Curtis felt that ANUD was a major ground layer species of that community.

Taken from Curtis, John T. Vegetation of Wisconsin, University of of Wisconsin Press, Madison, 1959.

APPENDIX

Age Measurement of the Rhizome of Aralia nudicaulis



Estimate	Mean(years)	STD DEV	Range(years)
Conservative	4.95	4.48	1-19
Liberal	8.47	4.44	3-21
Average	6.71	4.75	1-21
Difference (error)	3.53	SE= 2.25	0-8

$$\text{Average} = \frac{\Sigma(\text{Liberal} + \text{Conservative})}{\text{Total}}$$

$$\text{Difference} = \frac{\Sigma(\text{Liberals} - \text{Conservatives})}{\text{Total}}$$

N = 19

The process of counting the years on an ANUD rhizome is somewhat difficult. Some arbitrary decisions are made in reference to what constitutes a new year. I calculated age in 3 ways. 1. The conservative method: (A) I counted growth scars that appeared to be a distinct unit at the top. 2. The Liberal method: (C) I counted all scars until the branch point or until there was a true runner. The count I used in the paper was an average of the two.

B? – explain diagram

REFERENCES

Baldwin, W. K. W. Plants of the clay belt of northern Ontario and Quebec. National Museum of Canada, Bulletin No. 156, Dept. of Northern Affairs and National Resources, Canada, 1958.

Blakiston's New Gould Medical Dictionary (1st Ed.) The Blakiston Co. Philadelphia, 1949.

Curtis, J. T. The Vegitation of Wisconsin. University of Wisconsin Press, Madison, Wisconsin, 1959.

Desmore, F. Uses of Plants by the Chippewa Indians. 44th Annual Report of the Bureau of American Ethnology to the Secretary of the Smithsonian Institution, 1926-1927, U.S. Gov. Printing Office, Wash. D.C. 1928.

Edwards, Joan. Personal Communication, Dept. of Biology, Williams College, Williams Town, Mass, July 9, 1981.

Edwards, Joan. Unpublished Manuscript, Herbivery by Moose on Aralia nudicaulis.

Fairchild, Polly, Personal Communication, Student, UMBS, Pellston, MI, August 6, 1981.

Fernald, M. L. Gray's Manual of Botany (8th Ed.), New York, Van Nostrand Reinhold CO. 1950.

Hardin, J, W. & Arena, J. M. Human Poisoning From Native and Cultivated Plants (2nd Ed.) Duke Univ. Press, Durham, NC, 1974.

Martin, A. C., Zim, H. S. & Nelson, A. L. American Wildlife and Plants McGraw Hill, New York, 1951.

McGraw-Hill Encyclopedia of Science & Technology. McGraw-Hill, New York, 1966.

Mellichamp, Lawrence F. Personal Communication, Univ of North Carolina at Charlotte Univ. Dept. of Botany. July 2, 1981.

Merck Index. (7th Ed.) Merck & Co. Inc., 1960.

Peterson, L. Edible Wild Plants of Eastern & Central North America. Houghton Mifflin Co. Boston, 1978.

Peterson, R. T. & McKenny, M. A Field Guide to Wildflowers. Houghton Mifflin Co. Boston, 1968.

Ridley, H. N. The Dispersal of Plants Throughout the World. L. Reeve & CO. Ltd., Kent, England, 1930.