HOPS AS A POTENTIAL CROP FOR WISCONSIN AND THE MIDWEST

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INTRODUCTION

The purpose of this paper is to present the hop plant, and more specifically, the old world, or aroma-type hops, as a profitable crop for Wisconsin and the Midwest. Virtually all hops grown commercially in the U.S. come from the Pacific Northwest, yet aroma-type hops tend to be rather low-yielding there. Based on an analysis of biotic and physical factors pertaining to hops growing, and on first hand experience of a small-time hops producer and of the author in northern Wisconsin, it seems apparent that Wisconsin is suitable for growing hops and could be economically competitive with the Pacific Northwest for a certain segment of the hop market.

BOTANICAL DESCRIPTION

The common hop, *Humulus lupulus* L. (Cannabinaceae), is a temperate vine with a perennial subsurface crown of fleshy rhizomes and vigorously growing annual bines. The plant is dioecious, and only the female plants are generally grown in a nursery. The somatic chromosome number is 20. The bine climbs any available surface, forming a clockwise helix, which clings via six longitudinal rows of stiff bristles. Shoots which find no support cannot grow upright themselves and form a bramble, which tends to remain insignificant in size compared to the uprights. Lateral branches form more frequently as the height of the bines increase. These laterals bear the inflorescences and cones. The hop cone consists of a zig-zag rachis with a pair of membranaceous green bracts subtending smaller, inner bracts at each node. When they mature, these inner bracts bear small yellow glands containing lupulin, and may contain seeds, depending on the hop variety.

There are three general categories of commercially grown hops: American varieties (hybrids of native American hops), the new high-alpha or extract varieties, and the old-world or aroma varieties. The latter of these is of chief interest in Wisconsin.

AGRICULTURAL HISTORY

The date of first use of hops for flavoring beer is not well documented, but seems to have occurred in twelfth century Germany (1) where the hop plant grows naturally. Cultivation of hops spread through the continent to England by the sixteenth century, where a relatively large industry developed. Hops were introduced into America in 1629 (2), but did not become an important field crop until the early nineteenth century, during which time they spread from the eastern seaboard to the Midwest, and then to the Pacific Northwest. Downy mildew, (Pseudoperonospora humuli) almost eliminated New York's hop production during the 1920's. New York remained the major hop producing state until the hop louse (actually an aphid) decimated its crops, and Wisconsin was for a brief but very prosperous period a major hop-producing state. The hop industry continued to move west to California and the Pacific Northwest. By 1909 California had overtaken New York as the leading producer in America, and 1920 was the last year in which New York retained a place in U.S. hop-production statistics. In 1922, Oregon assumed U.S. leadership in hop production, and in 1943 Washington took the lead, which it retains to the present. Virtually all aroma-type hops are now grown in Washington, Oregon, and Idaho. (See Fig. 1 for location of major hop growing areas and Table 1 for acreage of aroma-type hops by state.) Hop growing has tended to be a very volatile industry, chiefly for economic reasons which will be discussed later. The bottom line for the supply side of the industry has been that maximum salable yield per plant is of utmost importance, and whenever a new region or site produces a superior yield, it tends to become the top producer for the particular variety within several years.

SOILS

The hop plant grows vigorously and will make good vegetative growth on a variety of soil types, even in relatively poor soil. Its fruiting capacity, however, is much more closely dependent on soil conditions. Especially important are good water-holding capacity and adequate drainage, for the hop has an extensive root system and a great need for water and nutrients for its multiple shoots--which often grow 20-25 feet in a year. The ratio of nutrients needed per amount of dry matter fixed is high. Compared to cereal crops in general, the nitrogen and potassium needed per unit dry weight increase are both about 2:1, with phosphorus being 1:1 (3). Clean cultivation is usually practiced in hop growing. On ideal loamy soils, compaction from tractors and equipment can be a problem. Therefore, subsoil plowing of wheeltrack areas is usually practiced because hop rows are permanent and cannot be changed in orientation from year to year. Even ideally structured loam soils are usually unable to retain an optimum field moisture content throughout an average year in most regions, so irrigation is practiced in most hop nurseries (4). The capital expenses necessary for hop growing make a high crop yield imperative, so use of high-quality land and irrigation is preferred.

RESEARCH NEEDS

There are several general categories of hop research. The Hop Research Council, an organization supported by grower's associations and handlers, funds research to develop new varieties with higher hop yields, higher alpha acid content, resistance to shattering, and resistance to fungal and viral infection.

Research to develop other possible growing regions in the U.S. (and possibly Canada) is being done informally and independently by growers trying their luck in new geographic areas. This was how the hop plant was introduced into the Pacific northwest. It seems likely that more northerly regions than those currently producing hops commercially are good candidates for new trials, especially of aromatic hops.

SUMMARY

Hops are a high value crop, with high capital and/or labor costs, depending on how they are grown. In order to succeed with mechanical harvesting and handling methods, larger-scale plantings are necessary. Profitable growing, especially of high-value aromatic hops for use in more exotic beers, is possible on a small scale with hand labor. An adequate specialty market exists in the Midwest for aromatic hops. The Midwest has the highest concentration of breweries in the country, so shipping costs for Midwest growers should not be high.

Much of northern Wisconsin, northern Minnesota, and Upper Michigan have suitable conditions for growing aromatic hops. Yields in a small northern Wisconsin yard have equalled yields in the Pacific Northwest for most aromatic varieties.

Most, if not all, of the needed conditions for successful hop growing in the Pacific Northwest can also be found somewhere in Wisconsin, with the exception of rainfall per year. If the water table is within reach of hop roots (i.e., 5 feet) the importance of rainfall is reduced. If not, irrigation can be used. In other physical factors, such as day length, soil conditions, and mean summer temperature, Wisconsin is similar to or more favorable than most hop growing regions in the Pacific Northwest.

ECONOMIC FACTORS

After leaving the hop yard, hops exhibit some tendencies even more interesting and unusual than their growth. Hops are a good example of an inelastic commodity, as they are used almost strictly for brewing. In brewing there are no substitutes for hops. Therefore, except for a small qualification or two, demand for hops has a strong, direct relationship to the market demand for beer. One of the qualifications is the variable hopping rate used by brewers, which has tended to decrease slowly over the years for the average American beer. Another, and perhaps more important variable in hops demand, is the proportion of the market held by various types of beers. There may be a 500% or more difference in the amount of hops used in brewing a typical American Lager and a European-Style Lager. Changing tastes to more exotic or special beers, which seems to be a growing trend, will necessitate increased production of aromatic hops, for it is largely through hopping that a beer acquires distinctiveness. Aside from these situations, the demand for hops is remarkably steady. Hops, especially the aroma-type, are a relatively high value crop. Large breweries pay about $1.35/lb for standard, medium alpha kettle hops, and $1.30/lb for high-extract types (11). Prices for aroma-type hops are higher than these.

An ample market for smaller scale producers of aroma-type hops exists in Wisconsin and the Midwest. It consists, in part, of "microbreweries" or small, local breweries producing specialty beers. These brewers tend to use a high hopping ratio and pay more for their hops, and their beers are increasing in popularity. Another market is the home-brewer supply store. These stores are found in most medium and large cities, and are usually willing to buy locally produced hops. Other markets consist of independent hops suppliers, such as Freshhops, a Wisconsin dealer, and organic herb shops.

The grower cited earlier in Antigo, Wisconsin has consistently had no trouble selling all of his hops at satisfactory profit levels during the past seven years. The hops are grown organically, using little or no synthetic fertilizers or pesticides, and are harvested by hand. The grower conducts his operation without additional labor. In most hop operations labor costs normally amount to about 40-45% of total production costs (12).

BRIEF SUMMARY OF A TYPICAL GROWER'S YEAR

In the spring, any surviving portion of the previous season's bine is cut back to the head (to control the number of shoots emerging) and the heads are shaped by cutting to maintain a manageable size. In early to mid May the emerging bines are manually attached to strings which hang down from a permanent trellis over each hop hill (Fig. 4). At this point the bines are 12-18 inches long. There are many variations in string arrangement and number of bines per string. The hop hills must normally be pruned again several weeks later to eliminate unwanted shoots. As the season progresses and the bines climb the strings, the lower leaves are sometimes stripped off for disease control. Fungicides and pesticides are sprayed from tractors, the frequency of application varying with conditions of the particular year. In dry years, very little or no spraying may be necessary, but in very wet periods fungicides may be applied only days apart to replace the chemical that was washed off by rain. Spraying during moist conditions may compact finer-textured soils. Hop cone ripeness is judged by various outward signs which indicate that the lupulin glands are completely filled with resins and that alpha acid and aromatic quality are fully developed. Hallertauer and Tettnanger, two aromatic varieties of German origin, ripen in northern Wisconsin site near Antigo in late August. The cones are then harvested by machine in most nurseries, but may still be harvested by hand in a few of the smaller nurseries. The cones are dried in 'oasts' (essentially drying rooms) and may be rehydrated slightly to reduce cone breakage. They are then baled for shipment to breweries. Alternatively, the cones may be ground and processed into pellets or extract.

COMPARISON OF WISCONSIN AND THE PACIFIC NORTHWEST

Following is a comparison of yields and physical factors found in these two regions of interest. Yields of Hallertauer in Boise Valley, Idaho averaged about 800 lb/acre. In the Bonner's Ferry area, the yield is reportedly higher, but no statistics are available. When grown organically in Wisconsin, Hallertauer often matches the 800 lb/acre figure. Yield of the Fuggle hop, even in prime Oregon yards, is 1100-1400 lb/acre. In Antigo, Wisconsin, the Fuggle hop yield is around 1200 lb/acre. The best West Coast yield for Tettnanger is approximately 1000 lb/acre at Bonner's Ferry, Idaho vs. 800 lb/acre at Antigo, Wisconsin. These comparative figures must be interpreted with caution, as they are based on different planting densities. In the Pacific Northwest, 1000-1500 hills (plants)/acre are common, and higher densities are sometimes used. The Wisconsin figures are based on 800 hills/acre. Burgess (1964) has shown that a higher planting density produced more yield per acre in all varieties tested in English hop yards (9). A report was published in 1867, during the Wisconsin hop boom, of a Wisconsin grower who raised 3100 lb of hops on a single acre (10). Regardless of the accuracy of that figure, hops have given large yields in Wisconsin, and current experience shows that this is indeed possible if the hops are given proper attention. Alpha and beta acid levels, and aromatic levels, have also been adequate in Wisconsin.

CLIMATIC INFORMATION

The hop plant will flourish vegetatively in most temperate areas. However cone quality (the percentage of alpha acids, beta resins, and other aromatic constituents) seems to depend on mean temperature and hours of sunshine during the cone ripening period, particularly during August (5). Burgess (1964) reported an increase in alpha acids with increasing sunshine and mean atmospheric temperature for hops grown in England (Figures 2 and 3). In Idaho, the Hallertauer hop exhibits a yield and vigor response to longer day length. When grown near Bonner's Ferry, Idaho, it matures about 10 days later than the same hop grown 400 miles south in the Boise Valley. The hop bines at the northern site are generally stockier and stronger growing, with higher yields of cones. Steiner (1986) contends that the longer day length is responsible for the delay in maturity (6). Other investigators have also reported an increase in vigor and fruit yield with increasing latitude (7). Southern exposure can give plants an earlier start in spring, allow them to accumulate more heat units and sunshine during the season, and extend the growing season further into the autumn. The Pacific Northwest may have sharply contrasting microclimates in the same general area due to varying proximity to air masses influenced by the Pacific Ocean, to various mountain ranges, and to generally steep topography.

PEST PROBLEMS

The primary fungal disease affecting hop plants is downy mildew, an obligate parasite which generally depends on humid or wet conditions to infect hops. Depending on the time and severity of infestation, downy mildew may merely weaken the plant, or reduce yield sharply, or even kill the bine. Bordeaux mixture, copper oxychlor, and zineb are effective controls. Another equally dangerous fungus, <u>Verticillium albo-atrum</u>, causing verticillium wilt, has been a problem in Europe but not in the U.S. Neither of these diseases has been a problem in Wisconsin in recent years.

Insect pests that are most damaging to hops in Wisconsin are the hop aphid, <u>Phorodon humuli</u> Schr. (nymphs, or juveniles, are called "hop lice" by hop growers), and red spider mites <u>Tetranychus urticae</u> Koch. Pyrethrum has given adequate control of these insects in Wisconsin (8).

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2. Burgess (ibid) pg. 17

3. Burgess (ibid) pg. 116

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5. Burgess (ibid) pg. 80

6. Steiner book III (ibid) pg. 49

7. Burgess (ibid) pg. 67

8. Michal Matucheski (personal communication)

9. Burgess (ibid) pg. 84

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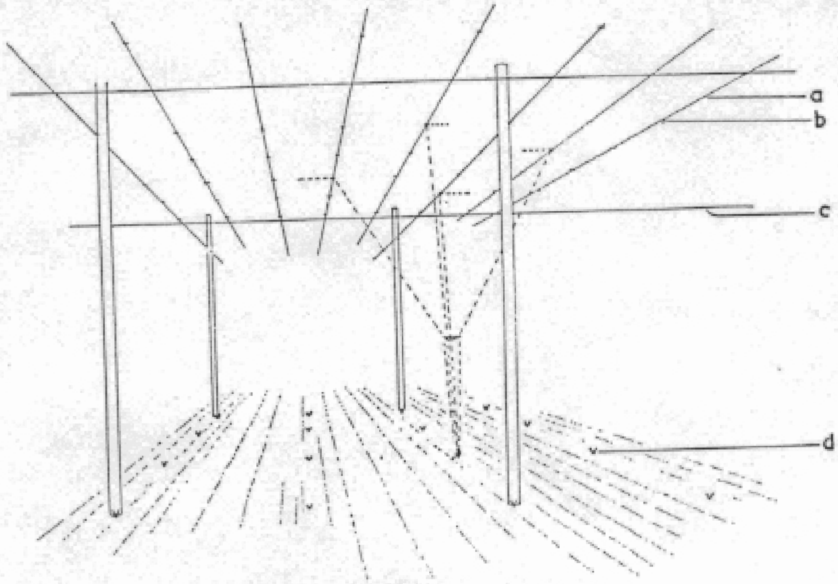
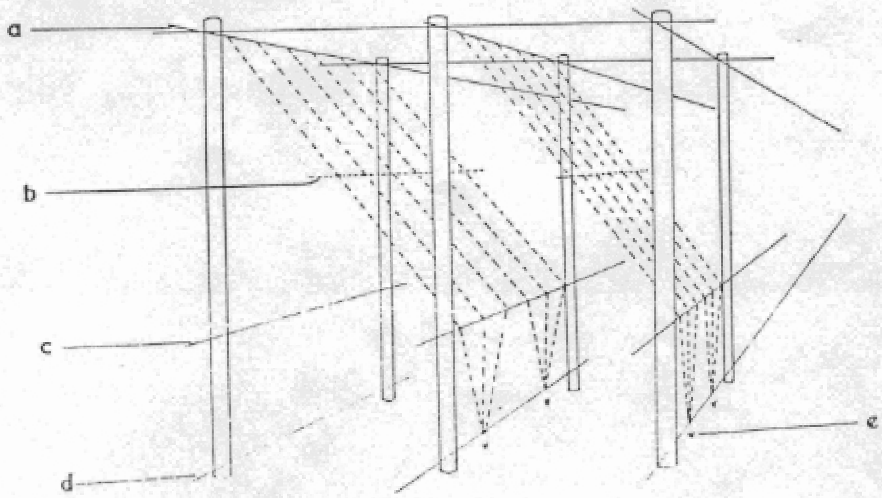
11. Mark Kessnich (personal communication)

12. Steiner Book III (ibid) pg. 74

FIG. 4 DIAGRAMS OF SOME HOP-TRELLISING SYSTEMS



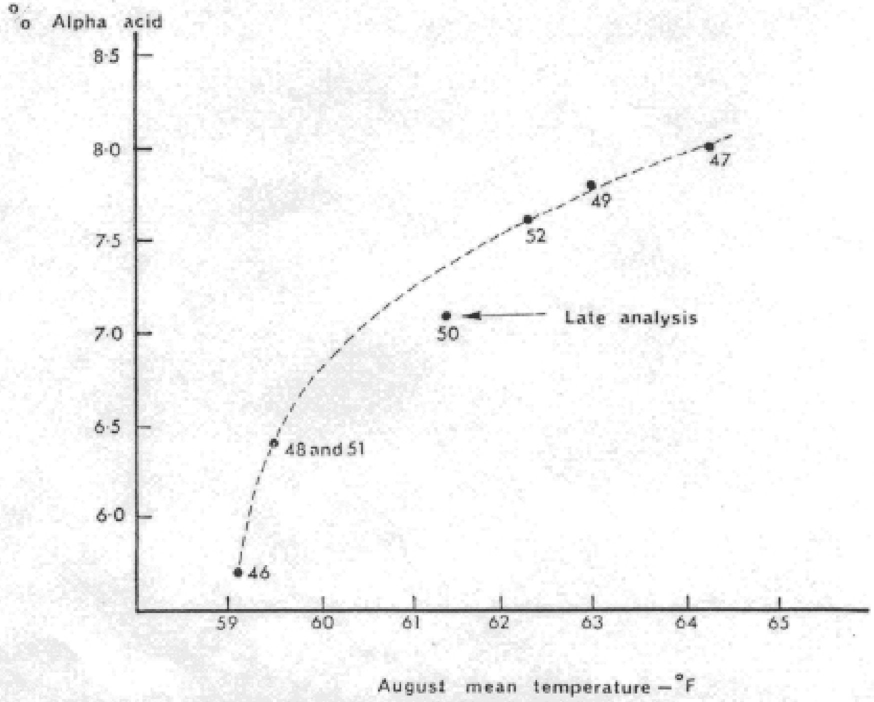
—Umbrella system of wirework.
a: Parallel wire.
b: Hooks attached to parallel wire.
c: Bearing wire.
d: Hill.



-Butcher system of wirework.
a. Top wires.
b: Bracing string.
c: Breast-wire.
d: Bottom wire.
e: Hill.

FIGURE 2

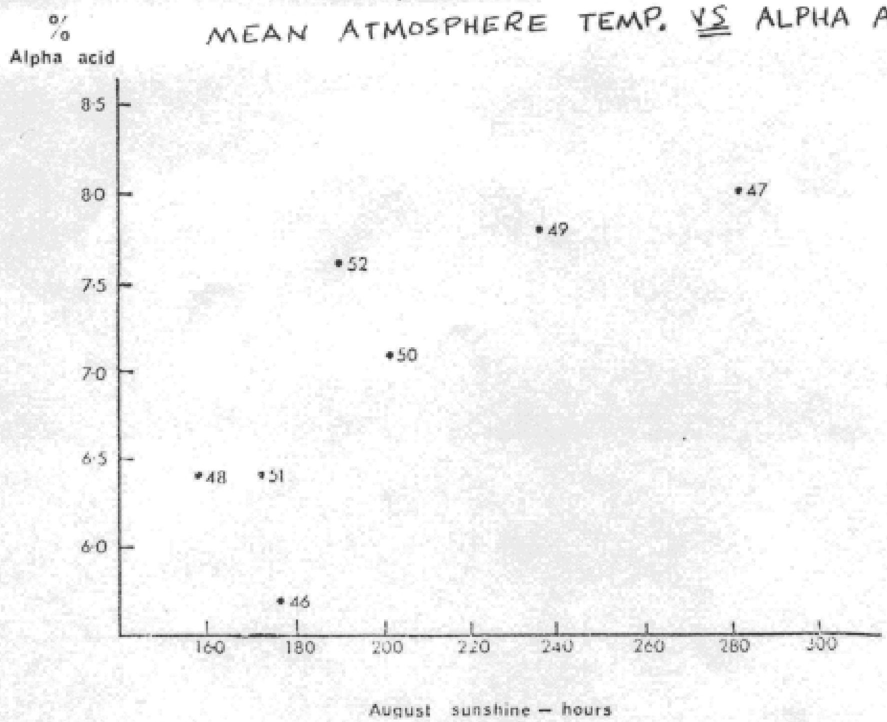
HOURS OF SUNSHINE VS. ALPHA ACID CONTENT



-Percentage of alpha-acid compared with the August mean temperature, 1946–52.

FIGURE 3

MEAN ATMOSPHERE TEMP. VS ALPHA ACID CONTENT



-Percentage of alpha-acid compared with the hours of August sunshine, 1946–52.

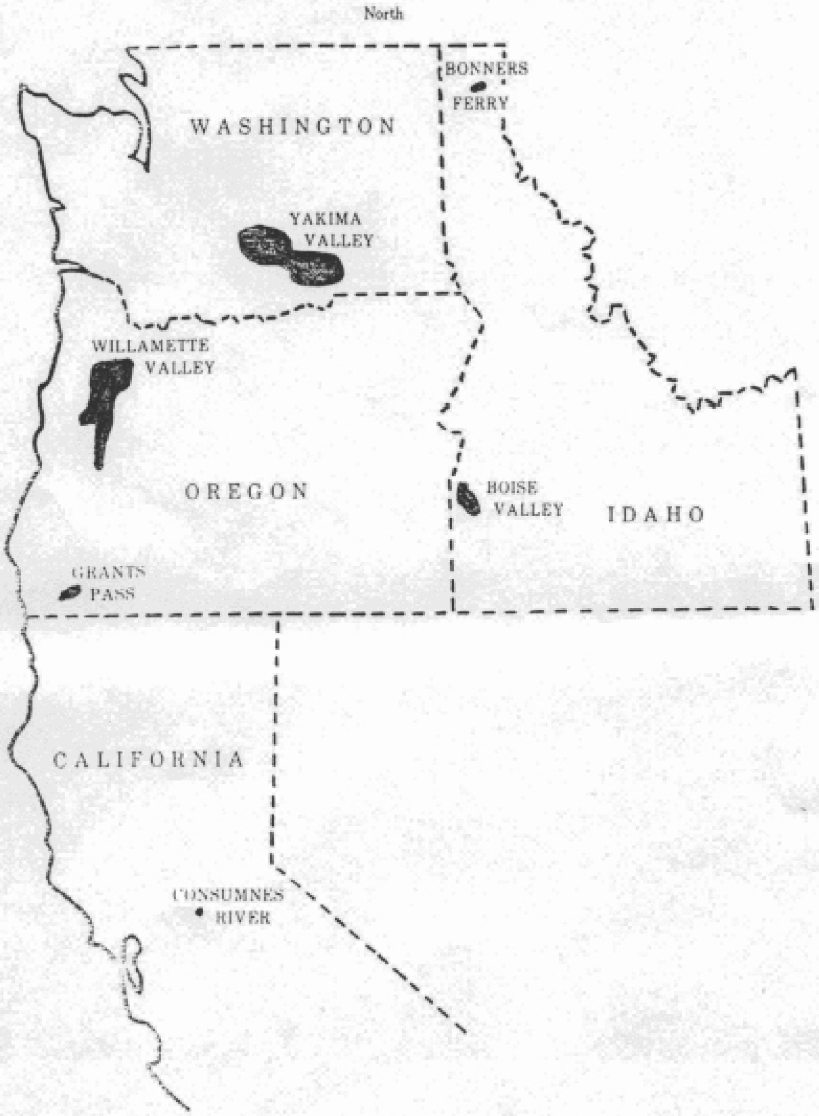
Source: A.H. Burgess, pg 77
(see bibliography)

Table 1. Distribution of commercial trellised United States hop acreage in 1985

Type or Cultivar	Washington	Oregon	Idaho	California	U.S. Total
Aroma types:					
Fuggles	72	1,414	0	0	1,486
Willamette	4	2,382	0	0	2,386
Columbia	0	100	0	0	100
Cascade	1,977	219	181	0	2,407
Hallertauer Mittelfrueh			274	0	274
Tettnanger	180	20	0	0	200
Medium Alpha Kettle Hops:					
Early Cluster including L-1 E-2	8,622	0	55	0	8,677
Late Cluster including L-8, California Cluster	2,065	25	534	35	2,659
Talisman	32	0	306	0	338
English Extract Hops:					
Brewer's Gold and Bullion	196	149	0	0	345
Premium Alpha:					
Galena	3,957	195	863	0	5,015
Eroica	853	454	828	0	1,726
Nugget	1,053	925	21	0	1,999
Olympic	196	2	0	0	198
Chinook	109	0	33	0	142
Others:	173	46	2	0	521

Source: S.S. Steiner Book III (see bibliography)

FIGURE 1 LOCATION OF MAJOR HOP GROWING AREAS



Source: S.S. Steiner, Book III pg 9
(see bibliography)