A STUDY OF QUANTITATIVE GENETICS ON SOME CHARACTERS OF THE MEADOWFOAM PLANT (*LIMNANTHES ALBA BENTH.*)

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Chin Lui *Foo*
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ABSTRACT

The meadowfoam plant is a moisture-loving native of the west coast of the North American continent near the borders of USA and Canada. It has recently stirred great interest in the chemical oil industry due to the potential of its seed oil to substitute for sperm whale oil. Due to the relative lack of published literature on this plant, an experiment was planned to study the quantitative genetics of some of its characters.

Thirty-six half-sib families were planted and the following characters were examined: plant height; diameter; uprightness; intensity of redness on branches and its distribution; leaf shape; period to first flower; seed set; mature seed retained; degree of seed shattering; and thousand-seed mass. Factor analysis was also performed on the flowering pattern of the plants.

Results indicated that all characters were heritable in the broad-sense, and all but two characters (diameter and degree of seed shatter) had significantly heritable narrow-sense heritabilities. The amount of genetic variability present in this species is also very high. Plant improvement methods based on selection are therefore recommended. Predictions on genetic advance show that the characters plant height, seed retention, leaf shape, and red intensity and distribution on branches showed greatest promise for rapid improvement.

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1.0 INTRODUCTION

1.1 Historical background to the meadowfoam plant

The meadowfoam plant (*Limnanthes alba*) has gained considerable interest due to the potential of myriad uses of its seed oil where industrial applications are concerned. It was first identified in the 1950s when the U. S. Department of Agriculture (USDA) conducted an extensive program to search for new crops amongst untested plants. The ideal new crop-plant candidate should fill a present or anticipated need and its usefulness should not compete with existing crops. This was done in part to alleviate the problems of massive surpluses of major food crops every year. Potential plant products and applications sought include cellulosic compounds for the pulp and paper industry, proteins for animal feed and industrial use, useful polysaccharides other than starch, natural toxins useful for pest and pathogen control, alkaloids, waxes, and unique vegetable oils (Earle *et al.*, 1959).

In the search for new plant products, oils receive special attention primarily because it has higher economic value per unit volume than proteins or fibres. It also has many applications in industry, the prime vehicle for value-addedness to a natural product. Industrial trends indicate increasing usage of oils as chemical intermediates in industry. It was of no surprise then, that greater interest was stirred when *Limnanthes* oil was named in 1971 as the most promising substitute for sperm whale oil (*Limnanthes* oil, together with *Crambe abyssinica* and *Simmondsia chinensis* (jojoba) oils were considered as possible substitutes for sperm whale oil (Hagemann and Rothfus, 1981)); after all sperm whale products were banned in 1969 when the Endangered Species Conservation Act was passed in the USA (Jolliff, *et al.*, 1981).

If successfully domesticated, demand for *Limnanthes* oil is expected to be strong, given that the US alone consumed 50 million pounds of sperm whale oil annually until 1972 for use in cosmetics, waxes, pharmaceuticals, lubricants, etc. Before attention was focused on its seed oil potential, the only cultivated species of *Limnanthes* was *L. douglasii* for its ornamental flowers (Purdy and Craig, 1987). The short life cycle and genetic variability suggests great potential for rapid crop improvement. The *Limnanthes* plants appeared to be efficient in the processing of raw matter and also produced a high ratio of seed to vegetative matter.

The seed oils are valuable because more than 95% of the fatty acids contain 20 or 22 C-chains which are mainly unsaturated at the 5C but sometimes at the 13C. This makes them suitable for a wide plethora of industrial uses such as waxes, lubricants, detergents, and plasticizers. Natural *Limnanthes* oil can be made into a liquid wax similar to jojoba oil, and when fully hydrogenated, a high quality solid wax about as hard as carnauba and candelilla waxes can be obtained. The oil content of *Limnanthes* seeds vary from 25-33% but fatty acid content of the C_{20}:1 type can be as high as 52-77% of the total seed oil (Higgins *et al.*, 1971).

1.2 Use of biometrics in plant improvement

Quantitative genetics deals with those traits which are expressed in a continuous spectrum rather than discrete classes. Most economic traits relating to yield fall within this definition. The manipulation of variation caused by genetic factors through breeding and selection forms the backbone of most plant breeding programs. The objective of plant breeding research is to enable better manipulation of these variations so that the desired qualities are realised.