Variation in *Senecio kirkii* Hook.f.

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[*Read before Auckland Institute, October 29, 1942; received by the Editor, October 31, 1942; issued separately, March, 1943.*]

SUMMARY.

EVIDENCE is presented to show that *Senecio kirkii* is a compound species composed of a broad-leaved and a narrow-leaved variety between which occasional hybridisation occurs.

The narrow-leaved variety further shows local race formation.

In both varieties leaf outline, corolla shape, and sap colouration vary considerably.

INTRODUCTION.

Senecio kirkii is a shrub or small tree endemic to the North Island of New Zealand. It is common in hilly and wooded districts, occurring from near sea level to about 3000 ft. According to Cheeseman (1) the leaves are " very variable in size and shape " (Fig. 1).

The present paper records a detailed investigation to determine whether the variation is due to differences in habitat or whether more than one variety exists within the species.

Observations were made in the following regions: North Cape District, Waipoua Forest, Trounson Park, Waitakere Ranges, Rangitoto Island, Hunua Ranges, Coromandel Ranges, Mt. Te Aroha, Mt. Pirongia, Mt. Egmont, Waimarino, Urewera Country, and the Tararua Ranges.

GENERAL.

A—Ecological Aspect.

In the early stages of the investigation it was thought that the two forms might be epharmones, as in general, plants with broad leaves and plants with narrow leaves occupy different habitats.

In the Auckland district, plants with broad obovate leaves are almost always epiphytic, growing on *Cyathea* spp., *Dicksonia squarrosa*, *Metrosideros* spp., *Collospermum hastatum*, *Freycinetia banksii* and moss and fern covered branches of large trees. Epiphytic plants of *S. kirkii* frequently attain large size. This is due in large measure to the presence of negatively geotropic adventitious roots which prevent the adult plant from falling away from its host (Fig. 3). The broad-leaved form thrives on the scoria of the Rangitoto Island lava fields, where other species normally epiphytic in rain forest also grow terrestrially. This form is strongly light-demanding, and it also requires a well-drained substratum such as is obtained in the epiphytic and lava field habitats.

The narrow-leaved form on the other hand is usually terrestrial and can tolerate rather more shade than the broad-leaved form.

Further investigation showed that the two forms were not epharmones:

1. Sometimes adult plants of both types grow together terrestrially (Fig. 2) and both may occur as neighbouring epiphytes under similar conditions (Figs. 3 and 4).

2. Notwithstanding changes in climate and habitat, leaves of both types are never found on the one plant. Several cases of natural transplanting have been observed, where a host plant bearing a broad-leaved *S. kirkii* has fallen to the ground. The epiphyte becomes truly terrestrial, yet the broad leaf-form is retained. With hemi-epiphytes the development of terrestrial rooting does not alter the leaf form.

3. The flowering seasons of the two varieties are different. Both epiphytic and terrestrial broad-leaved plants flower in spring and summer, while narrow-leaved plants in both habitats flower in autumn and early winter. (N.B. At Waipoua, in 1940, the narrow-leaved plants flowered in January, two or three months earlier than the normal time elsewhere. However, dead inflorescence stalks showed that the broad-leaved plants had flowered some time before this.)

Data appended to herbarium material in the Auckland Museum, the Dominion Museum, and the Botany Division (S. & I. R. Dept.), Wellington, support these observations which were made over three years.

4. In natural populations, leaves of seedlings are usually of the same type as those of adjacent adult plants.

Seeds from narrow-leaved and broad-leaved plants produced seedlings typical of the respective juvenile forms (see later). In this experiment seeds of each type were planted separately, at the same time and under similar conditions.

5. The broad-leaved variety is better adapted to withstand extremes of environment than the narrow-leaved variety.

(a) It can exist as an epiphyte in exposed positions.

(b) It is the form present on the exposed scoria of Rangitoto Island.

(c) On Mt. Te Aroha both forms occur together up to about 2000 ft. Above this altitude, to 3000 ft., only the broad-leaved form occurs.

(d) Comparable with (c) is the restriction of the narrow-leaved form to North of Lat. 38° S., while the broad-leaved form occurs over almost the whole of the North Island (see later).

(e) Broad-leaved plants are capable of a greater development of primary and secondary mucilage ducts and stone cells than narrow-leaved plants. These features in the cortex and pericycle of roots and stems are characteristic of xerophytic adaptation and would explain, in part, the ability of broad-leaved plants to grow as exposed epiphytes.

It is obvious that while different ecological conditions determine which variety will grow in a certain habitat, they do not cause the diversity of form.

B—Distribution.

The distribution of the two forms gives evidence of their distinctness.

North of Kaitaia, only the narrow-leaved form was seen (near Te Paki and Parengarenga, North Cape Area).

Both forms occur together from the Maungataniwha Ranges near Kaitaia, southwards to the Kaimai Ranges just north of Lat. 38° S.

From Mt. Pirongia (Lat. 38° S.) southwards, only the broad-leaved form occurs.

N.B. *S. kirkii* is apparently absent from the Waimarino Plateau, although only about 2,450 ft., where the low winter temperatures inland near the National Park accentuate the effects of altitude.

North of Lat. 36° S. (i.e., at Waipoua, Trounson and North Cape Area) all plants with narrow leaves bear a distinct hairy covering over the young stems and very young leaves. Broad-leaved plants of this region and plants of both varieties south of 36° S. are almost glabrous (Figs. 7 and 8).

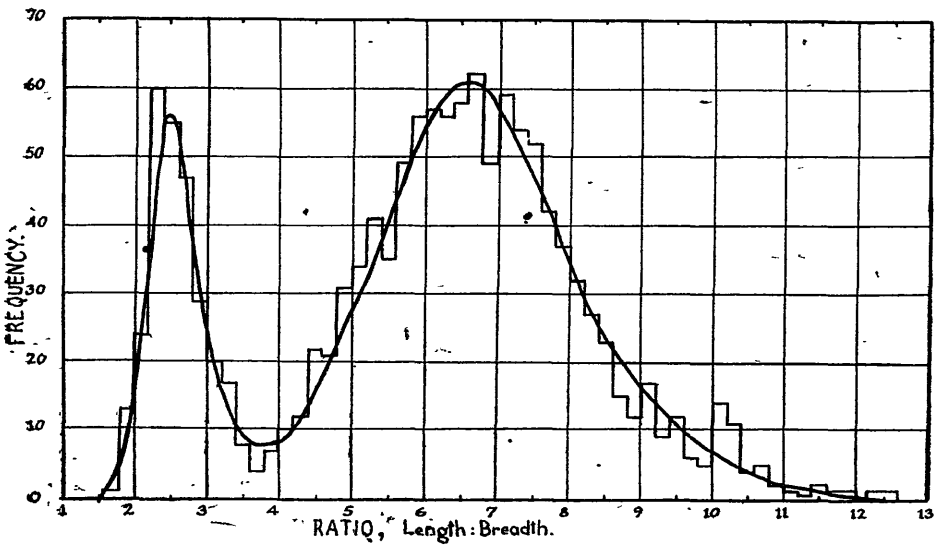
Cockayne (2) describes latitudes 38° S. and 36° S. as being the two most important " critical " latitudes limiting the distribution of plants in the North Island. It is significant that these latitudes are concerned in limiting the areas of distribution of the different forms of *S. kirkii*.

—Metamorphosis.

Seedlings from narrow-leaved plants have rather broad leaves at the base and show a gradual transition up the stem to leaves typical of the parent plant. Up to about twenty of these juvenile leaves are produced, the seedlings then being 3 to 4 inches high. These young seedlings are sometimes difficult to distinguish from those of the broad-leaved variety, but the first leaves of the latter usually narrow more abruptly to the petiole than do those of the former (Figs. 9 and 10).

When the leading shoot of a narrow-leaved plant is broken, new shoots which develop just below the wound frequently show a reversion to the rather broad juvenile form, with a fairly rapid transition to the typical leaf form (Fig. 5).

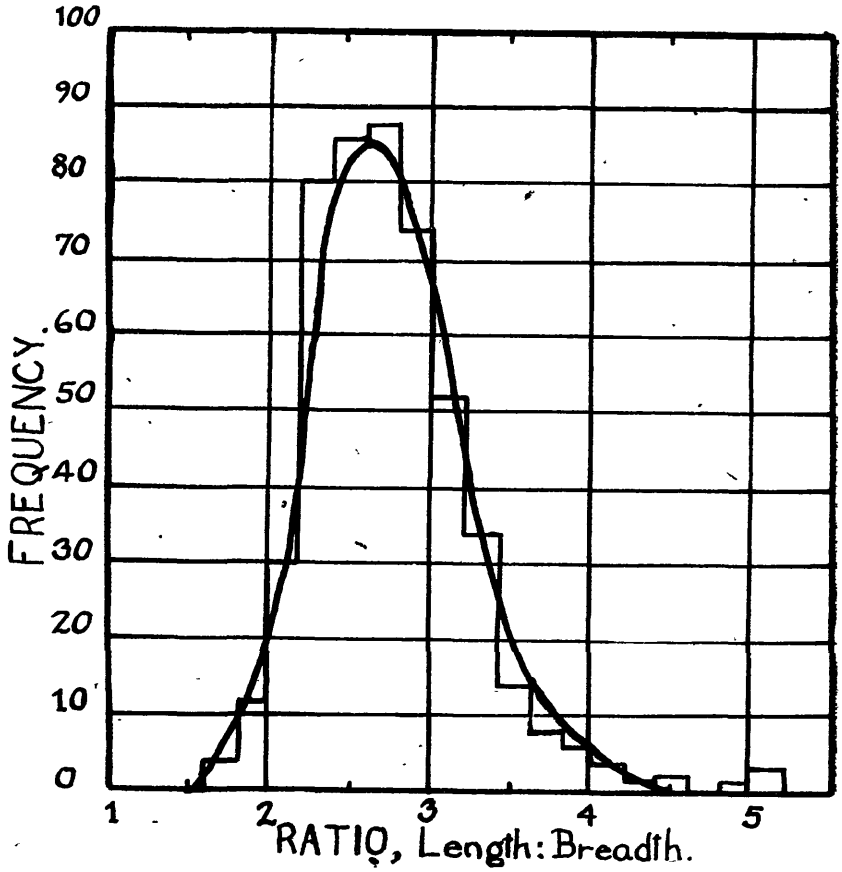
These are the only occasions on which individual plants show marked differences in leaf form.



TEXT FIG. 1.—Leaves from Waitakere Ranges.
Unit ratio—0.2. Number of leaves—1324.

D—Analysis of Leaf-form Variation in Natural Populations.

Method.—One leaf was removed from the centre of the leafy region of the nearest branch of each plant encountered in several populations of *S. kirkii.* The ratio of length to breadth was calculated for each leaf, and frequencies plotted against the ratios.



TEXT FIG. 2.—Leaves from Mt. Pirongia.
Unit ratio—0.2. Number of leaves—494.

Results.—The results show that for populations containing plants of both types two distinct curves are obtained, one with a mode approximately at ratio 2.5 and the other at about 6.5 (Text Fig. 1).

For populations with only broad-leaved plants, a single curve is obtained, the mode again being about 2.5 - 2.7 (Text Figs. 2 and 3).

When leaves of epiphytes only or terrestrial plants only are considered, a curve with two peaks of similar location to the above is obtained in each case, indicating that the leaf form is independent of the epiphytic habit.

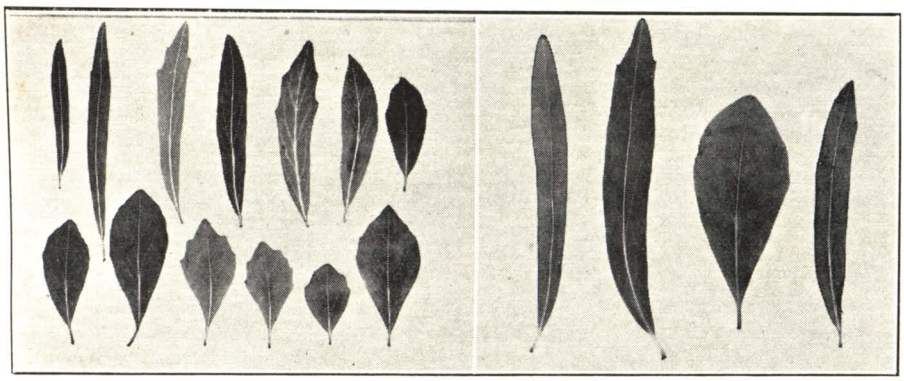


FIG. 1.—Leaf variation in *Senecio kirkii*—leaves from Waitakere Ranges.

FIG. 4.—One leaf from each of four epiphytes on the tree-fern. Left to right in order upwards from base.

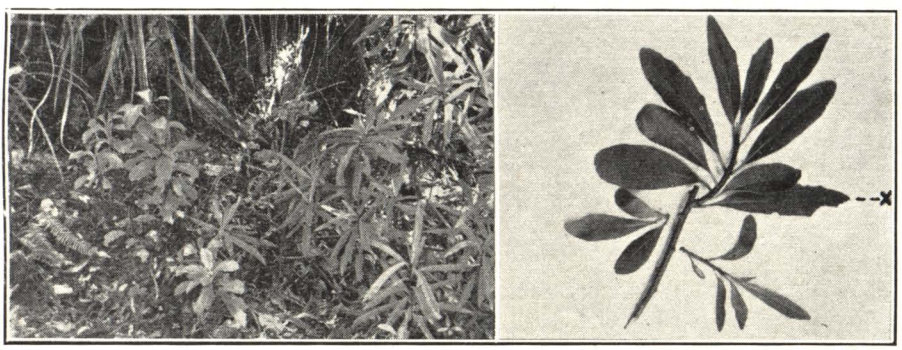


FIG. 2.—Broad- and narrow-leaved plants growing together terrestrially.

FIG. 5.—Reversion shoots after death of main shoot, narrow-leaved *S. kirkii*. Original leaf of shoot at X.

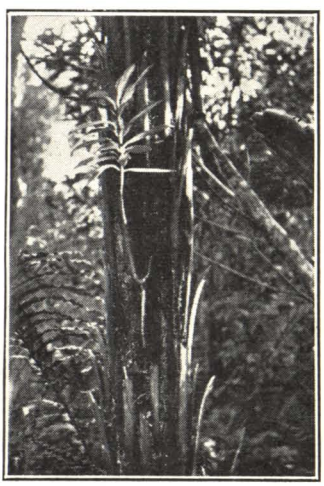


FIG. 3.—Narrow-leaved *S. kirkii* epiphitic on *Dicksonia squarrosa*. Note negatively geotropic root.

FIG. 6.—Two types of corolla shape from narrow-leaved *S. kirkii* with similar leaves and from similar growing conditions.

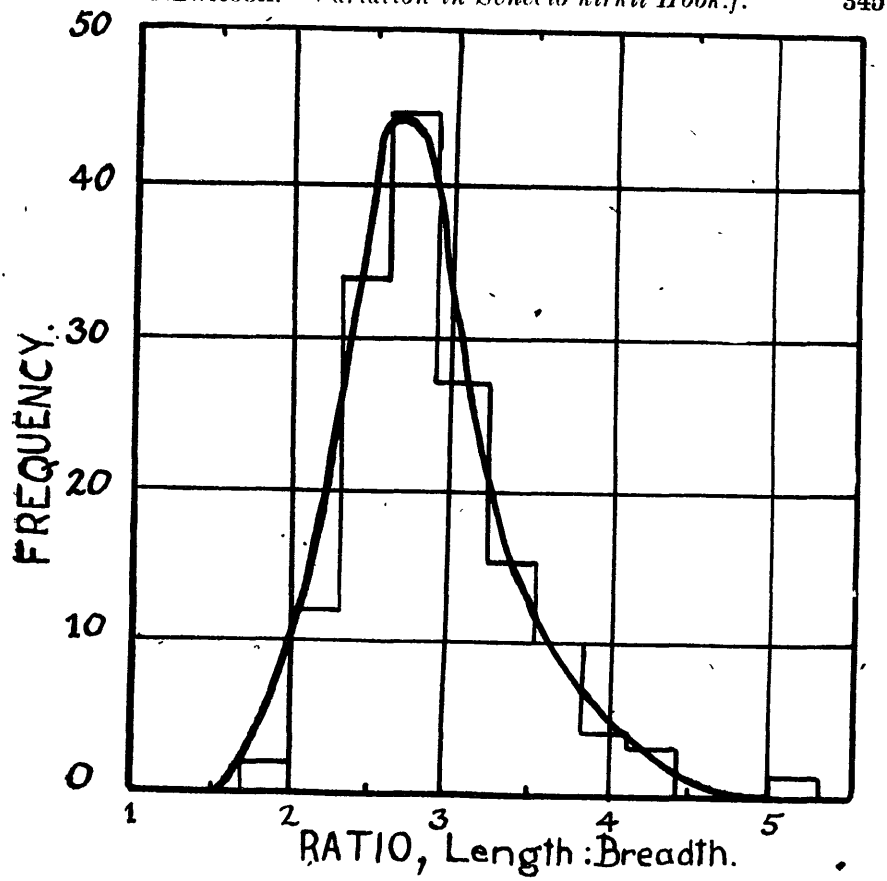
To face page 344]

FIG. 7.—Maximum development of hairs on *S. kirkii* from Waitakere Ranges.

FIG. 8.—Normal development of hairs on narrow-leaved *S. kirkii* North of Lat. 36° S.

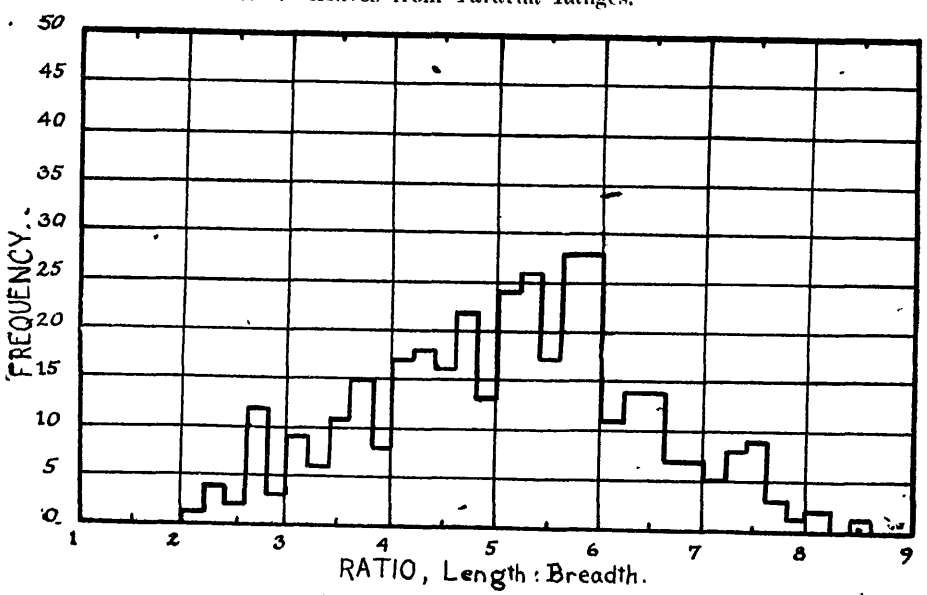
FIG. 9.—Seedlings from narrow-leaved *S. kirkii.*

FIG. 10.—Seedlings from broad-leaved *S. kirkii.*



Unit ratio—0.3. Number of leaves—153.

TEXT FIG. 3.—Leaves from Tararua Ranges.



Unit ratio—0.2. Number of leaves—324.

TEXT FIG. 4.—Leaves from hybrid swarm, Orere.

Frequency/ratio graphs for all the leaves from individual plants of *S. kirkii* were simple normal curves showing no greater variation than that in other species examined.

Conclusion.—The analysis of leaf-shape variation in natural populations shows that there are two constant and distinct forms of *S. kirkii.*

E—Hybridisation.

In April, 1940, near Orere in the Hunua Ranges, a few broad-leaved plants were flowering at the same time as the narrow-leaved plants. On a ridge in this district there occurs what appears to be a typical hybrid swarm covering a few square chains. Text Fig. 4 illustrates the curve obtained from material of this region. This curve indicates that a large number of the plants in the swarm are of intermediate type between the typical narrow and broad-leaved forms. The comparative lack of the latter is due to there being no large trees and few tree ferns for broad-leaved epiphytes to become established.

In the Waitakere Ranges occasional small groups of plants show rather intermediate form. Isolated plants of each type have been observed flowering between the normal flowering seasons, and though infrequent, these may provide the means for occasional hybridisation.

F—Minor Variation.

(a) The *leaf margin* in both forms varies from almost entire to sinuate, coarsely serrate or dentate (Fig. 1). Seedlings from one parent plant may vary in this respect.

(b) *Corolla shape.* Fig. 6 shows the inflorescences from two neighbouring plants with almosts identical leaves. Such differences in corolla shape are occasionally to be found in plants of both varieties.

(c) *Development of purple sap pigment.* Plants of either type, even when growing alongside one another, vary in the amount of pigment produced on leaves and young stems in strong light.

(d) In addition to having tomentum on young stems and leaves, many of the plants (all narrow-leaved) at Te Paki, in the North Cape Area have rather oblong leaves with the blade narrowed abruptly to a very short petiole. These leaves are further crowded into compact " rosettes " at the ends of the branches, the two features together constituting a distinct local characteristic.

ACKNOWLEDGMENTS.

Thanks for helpful criticism during the research are due to Professor T. L. Lancaster and Mr L. H. Millener of the Auckland University College, and to Mr. J. C. Neill and Dr. W. D. Reid of the Plant Diseases Division, S. & I. R. Department, Auckland, for similar help during the writing of the paper.

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