

FOLIAR SPIRAL AND PTYXIS IN *CORDYLINE RUBRA* HUEG. EX KUNTH

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The leaves of *Cordyline rubra* are arranged in two spirals, running clockwise or counter-clockwise in a shoot. Two successive leaves of a spiral make a deflection of about 40° between them. The right- and left-handed shoots in a population of 363 shoots occur almost equally, the difference being not significant statistically. The lamina and the petiole of *C. rubra* which has a sheathing base convolute in bud, and the direction of this ptyxis may be either clockwise or counter-clockwise. In majority of the shoots, the directions of foliar spiral and ptyxis are positively correlated, with only 18.69 per cent reversal. The reversal in the convolution is brought about by the 'perversion' of only the lamina portion since the petiolar sheath always rolls in accordance with the foliar spiral of a particular shoot. No explanation is so far available for the reversal, perhaps it has evolutionary significance.

INTRODUCTION

Cordyline rubra Hueg. ex Kunth (Agavaceae) is a pink-leaved shrub commonly cultivated in India as a valuable ornamental. According to Bailey (1958), the genus *Cordyline* has 10-12 species. Its leaves are alternate and arranged in two spirals veering either to the left (clockwise) or to the right (counter-clockwise) in a shoot. These two types of spirals are usually found on different shoots of the same plant. The lamina as well as the petiole, which has a prominent sheathing base, show clockwise or counter-clockwise convolution before unfolding. In this communication data are presented to show how the ptyxis in this species is correlated with the foliar spiral.

MATERIALS AND METHODS

All the shoots of 43 shrubs of *Cordyline rubra* grown around the premises of the Indian Statistical Institute, Calcutta, were examined in 1965 for their foliar arrangement. From 37 shoots of some of these plants, the convolution of the lamina was also recorded from 10 September 1965 to 9 April 1966. In addition, data were also obtained regarding their foliar arrangement and ptyxis from two varieties of *Cordyline terminalis* and *Dracaena marginata* grown in two gardens of Calcutta.

OBSERVATIONS

The two kinds of foliar spirals of *Cordyline rubra* are given in Fig. 1. Any two successive leaves of a spiral make a deflection of about 40° between them

which is more or less definite for a shoot with either left-handed or right-handed foliar spiral. The leaves produced in a spiral to complete a 360° revolution were counted in 22 left-handed and 23 right-handed shoots, and it was found that the tenth (9.96th to be precise) superposed the first leaf in the same spiral.



FIG. 1. Shoots of *Cordyline rubra*. L—shoot having left-handed foliar spiral. R—shoot with right-handed foliar spiral. The leaves of one of the two spirals in each shoot are numbered from the oldest leaf now available.

About 360 shoots on 43 *Cordyline rubra* plants were examined for their spirality, to find that the two types of shoots occur fairly equally, the difference not being important statistically even at the 5 per cent level of significance. The data of the four related species are presented in Table I.

In *Dracaena marginata*, the right-handed shoots are appreciably in excess of the left-handed ones and the difference is statistically significant, the χ^2 value with 1 d.f. being 6.537. However, when the data from the four species are polled, the left-right difference is far from being significant.

PTYXIS

The lamina along with the petiole is tightly rolled up in the bud stage and the direction of convolution may be left-handed or right-handed (Fig. 2B, D). The petiole also shows similar asymmetry (Fig. 2A, E). However,

TABLE I

Left- and right-spiralled shoots in Cordyline and Dracaena species

Species	Plants observed	Shoots with foliar spiral			$\frac{(L-R)^2}{L+R}$
		Left	Right	Total	
<i>Cordyline rubra</i> ..	43	165	198	363	3.000
<i>Cordyline terminalis</i> (Baptistii) ..	77	38	39	77	0.013
<i>Cordyline terminalis</i> (Ti) ..	21	104	103	207	0.005
<i>Dracaena marginata</i> ..	26	58	89	147	6.537
Total ..	167	365	429	794	9.555

$$\chi_1^2 = 5.159, \quad \chi_3^2 = 4.396$$

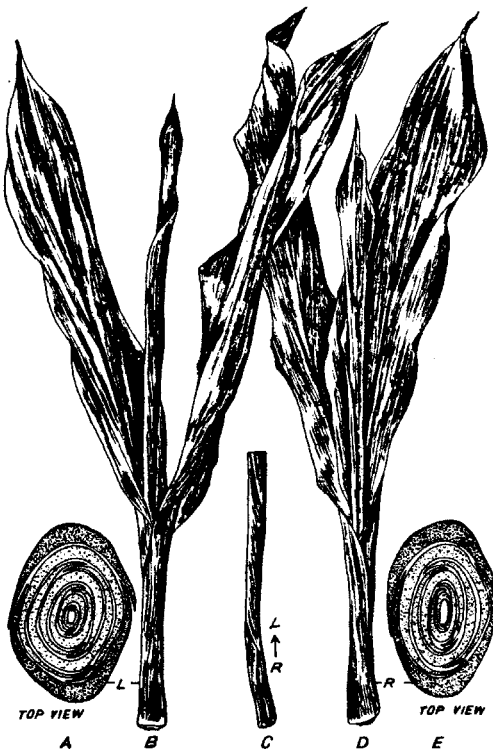


FIG. 2. Shoots and transections of the crowns of *Cordyline rubra* showing pre-foliation. The unfolding leaves in B, D show left-handed and right-handed convolutions respectively. A, E transverse of shoots B, D through the petiolar region. C—a portion of leaf where the petiole convolutes to the right, but the lamina above reverses in its ptyxis.

as the leaves of the bud enlarge, the petioles of the outer one or two leaves do not exhibit overlapping of their margins.

In order to find out whether the direction of ptyxis corresponds with the direction of the foliar spiral, the rolling of 519 leaves produced in seven plants was studied. Of the 37 shoots, 16 bore left-handed foliar spirals, and the rest right-handed ones. The data collected are presented in Table II.

TABLE II
Cordyline rubra: Foliar spiral and convolution

Plant	Shoot		Convolution of lamina			$\frac{(L-R)^2}{L+R}$
	Spiral:	No.	Left	Right	Total	
1	L	2	37	4	41	59.9
	R	5	24	89	113	
2	L	2	18	15	33	9.6
	R	4	16	52	68	
3	L	4	38	12	50	17.0
	R	2	10	23	33	
4	L	3	23	2	25	30.5
	R	3	5	25	30	
5	L	4	41	1	42	47.7
	R	2	2	17	19	
6	L	1	9	2	11	26.9
	R	4	4	42	46	
7	R	1	-	8	8	*
1-7	L	16	166	36	202	83.6
	R	21	61	256	317	119.9

* χ^2 not calculated, $\chi_1^2 = 214.8$

Excepting the last one, all the plants produced leaves having both right-handed and left-handed ptyxis. Four shoots having right-handed foliar spirals produced laminae with only right convolution and another five shoots having left-handed foliar spiral produced laminae rolling only to the left. However, plants 1-3, from where data were obtained for the entire period, did not possess even a single shoot having only one type of convolution.

The convolution of a leaf very strongly depends on the foliar spiral of the shoot on which the leaf is borne since the value of the χ^2 to test the independence of the two characters (foliar spiral and ptyxis) is 198.57 with one degree of freedom, which rejects the hypothesis at the 1 per cent level. As may be

seen from Table II, the directions of foliar spiral and convolution are more similar than dissimilar.

In 18.69 per cent of the cases, the convolution is just in a reverse direction to that of the foliar spiral. In order to get an explanation for this situation, many of the reversing leaves were dissected out and it was found that the petiole always shows the overlapping exactly in accordance with the direction of the foliar spiral, and only the lamina portion rolled differently. The reversal is perfect and the reversely-rolled lamina is as compact as a normal one (Fig. 2C). Among the two types of reversals, a right-hander reversing to the left is slightly more frequent (23.83 per cent) than the converse (21.69 per cent).

Examination of the pre-foliation of a few other species of *Cordyline* and *Dracaena* revealed that, as a general rule, the lamina rolls the same way as the leaves are arranged on the shoot. In *Dracaena marginata*, among the 147 unfolding leaves examined on 147 shoots in February 1967, none reversed, nor was there any sign of even a partial reversal. However, *Cordyline terminalis* (*Ti*) appears to be an intermediate case since, out of 207 unfolding leaves examined on an equal number of shoots, there was one complete and five partial reversals. Seventy-seven young unbranched plants of *C. terminalis* (*Baptistii*) were also studied. This variety somewhat resembles the variety *Ti* of the same species since four leaves showed partial reversal.

DISCUSSION

The pre-foliation varies greatly within species of a family and between different families. A situation comparable to that of *Cordyline rubra* exists in some Araceous members. In *Dieffenbachia* sp., the leaves in a shoot are arranged in two spirals which run clockwise or counter-clockwise. In a shoot with left-handed foliar spiral, the ptyxis of the lamina is always right-handed, and vice versa in a right-spiralled shoot. *Cordyline rubra* in this respect with its 18.69 per cent reversal is transforming to the condition of *Dieffenbachia* sp. more readily than many other species of Agavaceae and Liliaceae. In the case of *Scindapus officinalis*, a leaf of right convolution is generally followed or preceded by another with left-handed ptyxis (Davis 1969). This tendency may be attributed to the distichous nature of the leaves, since in grasses where the leaves are arranged distichously the laminae show a right followed or preceded by a left convolution. In *Ravenala madagascariensis* with its distichous leaves, however, over 95 per cent of the leaves have a right-handed ptyxis. In many species of *Musa* and numerous varieties of the cultivated *Musa sapientum*, though the leaves are arranged in two spirals (always right-handed), all the leaves have right-handed convolution which is just the reverse of *Dieffenbachia* sp. In *Canna*, *Maranta* and others, many species have distichous leaves, but they exhibit only right convolution. In a few other species of Araceae such as *Colocasia antiquorum*, *Alocasia indica*,

the leaves in a shoot show more or less the same kind of convolution. But different shoots from the same clump may have different convolution. It is, therefore, difficult to explain why in *Cordyline rubra* the foliar spiral and convolution are positively associated, and equally hard is to account for the about 19 per cent deviation. The foliar spiral in *C. rubra*, as with many other species of Agavaceae and Liliaceae, does not seem to be genetically determined as has been established in the case of *Cocos nucifera* (Davis 1962). The fact that both the kinds of foliar spirals are present in the same shoot may also suggest that this character has no genetic bearing.

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