Natural Hybridization Among Rhododendrons In Papua New Guinea

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What are Rhododendrons?

Rhododendrons belong to the family *Ericaceae*, which includes the Heathers (*Erica* and *Calluna*) which purple the hills in Scotland, and are found in many other countries too. It also includes the genera *Vaccinium, Agapetes* and *Dimorphanthera*, with several others which occur in Papua New Guinea.

Rhododendron, however, is by far the largest genus in the family, having some 850 species world-wide. They are shrubs or small trees, usually terrestrial but sometimes epiphytic (especially in P.N.G.). They are usually evergreen, though some (known as Azaleas) are deciduous. They have entire usually leathery leaves, and conspicuous flowers, usually in large trusses. The corolla is always united at the base, but variously divided above, usually into five lobes. The calyx is usually small and inconspicuous. The stamens are long and twice the number of the corolla lobes, and the ovary is single and superior, with a long style surmounted by a club-shaped stigma. There are nectaries at the base of the corolla tube. The flowers are nearly always brightly coloured, with a predominance of red, pink or purplish shades. Their colour prompted Linnaeus to name the genus *Rhododendron*, meaning 'Red Tree'.

They are very popular in cultivation all over the world, and there are many Rhododendron Societies. Thousands of artificial hybrids have been made. This paper concentrates on natural hybrids in one geographical area.

Geographical Distribution

Of approximately 850 species, 525 occur in Asia, 25 in North America, 9 in Europe and one in Australia. No less than 280 occur in the so-called Malesian region (Sleumer in 'Flora Malesiana'), which includes Papua New Guinea. Of these 163 are found in Papuasia, which includes the whole island of New Guinea (with West Irian), New Britain, Bougainville and the Solomon Islands, and neighbouring islands. No less than 161 of these are endemic, an astonishing total, giving a percentage endemism of 98.8%. However for the purpose of this study I am restricting my attention to those which occur within the territory of Papua New Guinea. These amount to a total of 87 species (so far discovered), of which all but two are endemic.

Classification

All members of the genus *Rhododendron* in Malesia belong to the Subgenus *Rhododendron*, characterised by the distinctive peltate scale found on the plants. (Stevens). These are very noticeable on some species, giving the young shoots and leaves a rusty velvety appearance (e.g. *R.superbum* and *R.phaeochitum*). All the species found in Papua New Guinea belong to the section *Vireya*, which has unicellular hairs as well as multicellular scales, and long tails or wings to the seeds, enabling them to be dispersed by wind. This section is subdivided into seven subsections, and one of these, Subsection *Euvireya*, is further split into five series. It is necessary to consider these divisions in order to understand the hybridisation which occurs.

Table 1.

Table of subsections and series of Rhododendron, Section Vireya in Papua New Guinea

Section: Vireya		
Subsection:	Abbreviation	
Pseudovireya	Ps	7 species
Siphonovireya	Si	4 species
Phaeovireya	Ph	24 species
Albovireya	Al	3 species

Solenovireya	So	17 species
Euvireya: Series		
Linnaeoidea	EL	4 species
Saxifragoidea	ES	1 species
Buxifolia	EB	9 species
Javanica	EJ	18 species
Total Section Vireya in P.N.G.		87 species
Hybrids observed:		
(a) by the writer:		23 hybrids
(b) by others (in addition)		4 hybrids
Total:		27 hybrids

Undoubtedly others must occur, which have not yet been observed.

Flower Types and Pollinating Agents

In order to understand and appreciate hybridization it is necessary to compare the flower types and relate them to possible pollinating agents. Flower types may be classified by shape and colour. (See Fig.1).

(1) Flower Shapes. The corolla is always united at the base, with a shorter or longer tube. It may be:

Widespreading with a very short tube, as in *Rhododendron macgregoriae*, the commonest species in P.N.G. (Type A1); Flaring, like a trumpet, e.g. *R.zoelleri* (A1), or *R.superbum* (A2); Campanulate, e.g. *R.christianae* (A1) or *R.inconspicuum* (B2); Tubular, straight or curved, long or short, e.g. *R.herzogii* (C) or *R.dielsianum* (B), with corolla lobes equal and symmetrical, e.g. *R.womersleyi* (B), or markedly unequal and zygomorphic, e.g. *R.atropurpureum* (B).

If curved, the curvature may be abaxial or adaxial. The mouth may be erect, horizontal or facing downwards.

The stamens may be abaxial, adaxial or all round.

(2) Flower Colours. The colour of the corolla may be: Red or pink, sometimes with a purplish tinge; White, often pink-to-red tinged at the base, occasionally with a deep red dot at the base of each lobe; Yellow, orange, or bicoloured; Very occasionally greenish yellow.

The large majority of white flowered species are strongly and sweetly scented. The others are not (unless pink forms of normally white species). The tubular-flowered species are nearly always red, pink or white. he open-flowered species are usually yellow or orange, often with darker tips.

The red flowered species are usually tubular, often zygomorphic and curved. The white-flowered species are of two very distinct types:

(a) Long, narrow and tubular, usually curved and scented (Subsections *Siphonovireya* and *Solenovireya*).

(b) Large trumpet-shaped, waxy, often with more than five lobes, very strongly scented. They include the largest-flowered Rhododendrons in the world (e.g. *R.superbum, R.konori* and *R.leucogigas*, whose flowers reach 20cm long and wide).

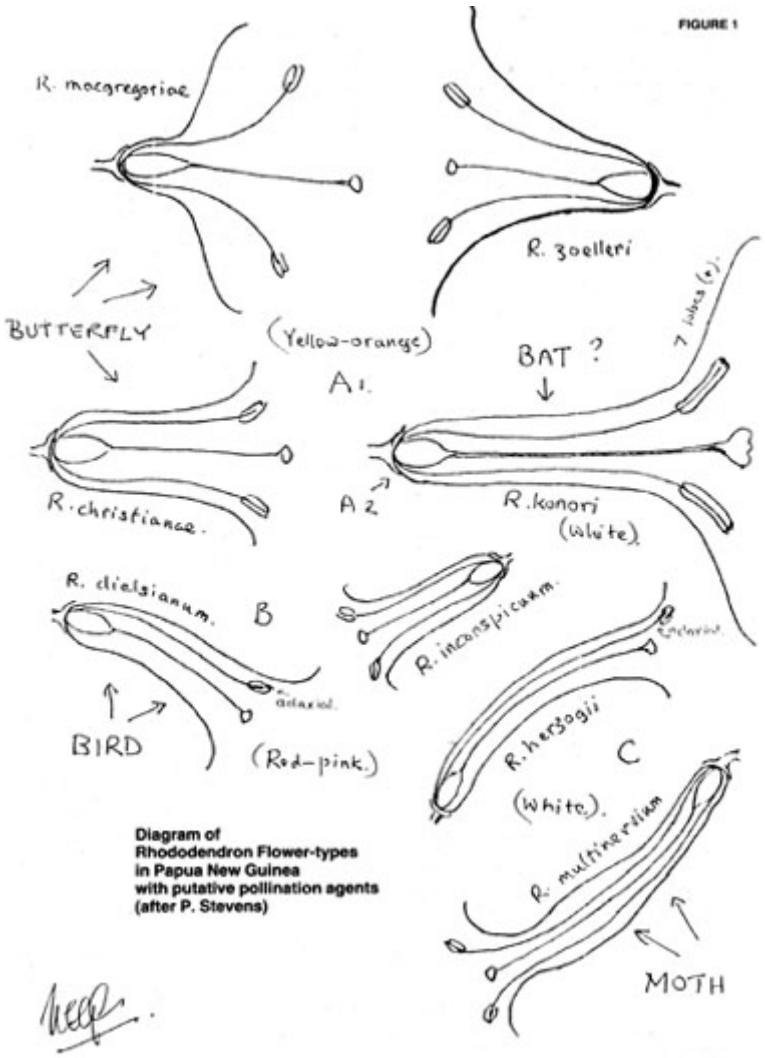

Diagram of Rhododendron Flower-types in Papua New Guinea with putative pollination agents (after P. Stevens)

Altitudinal Zonation

There is an altitudinal correlation too. In P.N.G. there are no Rhododendrons on the coast. The lowest altitude that I have observed them is in the Daga district of Milne Bay Province, where *R.christianae* occurs as low as 450m a.s.l. This is one of the yellow open-flowered group. This group occurs from 450m to 3500m! But only one member of the group, *R.macgregoriae* attains this altitude. Apart from this species, the others only reach to about 1700m. The white-flowered species occur from about 1000m. (*R.loranthiflorum*) to about 3000m with a peak at about 2000m.

The red-pink group range from about 1500m to 4000m+, i.e. to the highest limit of vegetation. They peak at about 3000 to 3500m in the subalpine shrubberies.

Pollination

Dr. Peter Stevens of Havard University in the U.S.A. (formerly at Lae) has deduced from these facts, and from observations in the field by himself and others that there is a correlation between flower-types and pollination. He concludes that:

(1) The yellow-orange wide-flowered species are mainly pollinated by butterflies;
(2) the white tubular-flowered species by moths (Sphingids);
(3) the large white waxy funnel-shaped species by bats (Paul Kores' theory, accepted by P. Stevens);
(4) and the red-pink flowered (mainly high altitude) species are pollinated by birds.

Commenting on these one by one:

(1) Butterfly Pollination

Flower type A1.

The low altitude yellow-orange-flowered species are ideally suited to be pollinated by butterflies. Their flowers are presented open and spreading in all directions and are bright and showy. Species of *Ornithopters* and *Papilio*, etc., have been recorded as visiting *R.zoelleri*. Dr. Stevens has personally seen a Papilio on *R.macgregoriae* and Fr. N. Cruttwell has seen butterflies on *R.macgregoriae* and *R.christianae*. *Delias* has been seen on *R.christi*. Bees commonly visit *R.macgregoriae* in Mt. Gahavisuka Park.

(2) Moth Pollination (Phalaenophily)

Flower type C

The white tubular flowers of Subsections *Siphonovireya* and *Solenovireya* are ideally suited to long tongued moths. The white colour and scent make them conspicuous at night. The flowers are displayed so that the mouth is facing more or less horizontally. This is done by either adaxial or abaxial

curvature. The moth presumably hovers while inserting its long tongue into the honeysuckle-like tube to suck the nectar at the base. It could hang on to the lobes with its legs. The anthers are usually adaxial, at least in the mature flower, and so deposit their pollen onto the moth's thorax or abdomen. This shape is typical of Phalaenophious flowers. (Faegri and Van der Pilz 1971 and Sleumer 1966). Dr. Sleumer does not mention whether such pollination has actually been observed, nor does Dr. Stevens, but the latter deduces that Sphingid Moths are responsible (presumably because they have very long tongues). The length of the tube may reach 9 to 10cm.

(3) Bat Pollination

Flower type A2.

The huge waxy-white to pinkish flowers of *R.konori, superbum, gardenia* and *leucogigas* do not appear to be suitable for moths. Paul Kores has suggested that they may be pollinated by bats. Dr. Stevens has concurred with that suggestion. Apparently the pollen of *R.konori* (?) has been found in the stomach of bats. Anyway the flower, being so large and conspicuous, with its heavy scent, should be perceptible by bats, with their weak eyesight and strong sense of smell. However actual observation of bat pollination is very desirable.

(4) Bird Pollination (Ornithophily)

Flower type B.

The typical red-pink species has a curved tubular zygomorphic corolla, bent adaxially so that the mouth is pointing downwards. This seems ideally suited to a bird of the Honey-eater type (*Melidectes, Myzomela,* etc.). Red is well known to be an attractive colour to birds. Many other bird pollinated flowers have red corollas, including *Dimorphanthera* (*Ericaceae*) and *Dendrobium* (*Orchidaceae*). The curvature of the flower just fits the curved beak of the bird, and the adaxial anthers are poised so as to deposit their pollen on the bird's head. The downward opening enables the bird to perch on the stem below and reach up into the flower. Birds of the genus

Melidectes and *Ptiloprora* have actually been observed feeding on *R.commonae, R.atropurpureum, R.beyerinckianum* and *R.womersleyi* on Mts. Wilhelm and Kubor. Though I have not personally seen birds feeding on Rhododendrons, I have seen a red-breasted Honey-eater feeding on *Dimorphanthera*, (which has similar red tubular flowers). I have also seen evidence of birds feeding on *R.phaeochitum* and *R.rarum*, as they had pecked the corollas near the base to get at the nectar, thereby cheating the flower of its pollination. *R.phaeochitum* has extra long corollas, and perhaps the bird's beak was not long enough to reach the nectar.

Thus there is considerable evidence for the four types of pollination in *Rhododendron* in Papua New Guinea. It is also evident that where two or three species grow together cross fertilization is likely to occur, resulting in hybrids - and this is indeed what we find.

Hybridization

List of Hybrid Rhododendrons recorded.

(Note. It is impossible to tell which is the pollen parent, and which the ovary parent, so that the names may be read in either direction).

(a) By N. Cruttwell.

	Polli-nator	Sub-section			Polli-nator	Sub-section
R.macgregoriae	By	EJ	x	*zoelleri*	By	EJ
R.macgregoriae	By	EJ	x	*christianae*	By	EJ
R.macgregoriae	By	EJ	x	*cruttwellii*	M	So
R.macgregoriae	By	EJ	x	*inconspicuum*	Bd	EB
R.macgregoriae	By	EJ	x	*dielsianum*	Bd	Ph
R.macgregoriae	By	EJ	x	*rarum*	Bd	Ph
R.macgregoriae	By	EJ	x	*phaeochitum*	Bd	Ph
R.macgregoriae	By	EJ	x	*commonae*	Bd	EB
R.macgregoriae	By	EJ	x	*stevensianum*	Bd	EB
R.christianae	By	EJ	x	*inconspicuum*	Bd	EB

R.aurigeranum	By	EJ	x	*konori*	Bt	Ph
R.zoelleri	By	EJ	x	*dielsianum*	Bd	Ph
R.herzogii	M	Si	x	*konori*	Bt	Ph
R.multinervium	M	So	x	*culminicolum*	Bd	EJ
R.culminicolum	Bd	EJ	x	*dielsianum*	Bd	Ph
R.dielsianum	Bd	Ph	x	*rarum*	Bd	Ph
R.scabridibracteum	Bd	EJ	x	*phaeochitum*	Bd	Ph
R.commonae	Bd	EB	x	*yelliottii*	Bd	Ps
R.yelliottii	Bd	Ps	x	*beyerinckianum*	Bd	Ph
R.yelliottii	Bd	Ps	x	*womersleyi*	Bd	EL
R.atropurpureum	Bd	EB	x	*womersleyi*	Bd	EL
R.leptanthum	Bd	Ph	x	*inconspicuum*	Bd	EB
R.gaultheriifolium	By	Ps	x	*womersleyi*	Bd	EL

(b) Hybrids recorded by others (Sleumer, Supplement)

R.beyerinckianum	Bd	Ph	x	*womersleyi*	Bd	EL
R.beyerinckianum	Bd	Ph	x	*culminicolum*	Bd	EJ
R.leptanthum	Bd	Ph	x	*gracilentum*	Bd	EL
R.konori	Bt	Ph	x	*zoelleri*	By	EJ

Pollinator: By - Butterfly; Bd - Bird; Bt - Bat; M - Moth

Subsection: E - Euvireya, Series; J - Javanica; B - Buxifolia;

L - Linnaeoidea;

Ph - Phaeovireya; Ps - Pseudovireya; So - Solenovireya;

Si – Siphonovireya

A diagram is appended below, showing the relationships of these hybrids. (Fig.2).

Figure 2

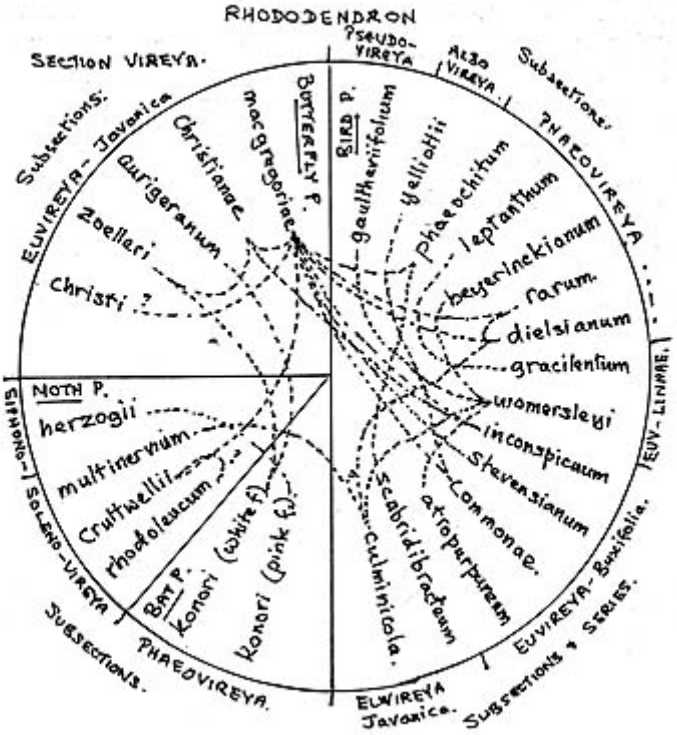

CHART SHOWING RELATIONSHIP OF HYBRIDS — Cruttwell, 1987

Discussion

It is easy to understand how species of similar flower type can hybridize. The pollinator simply moves from one flower to another, e.g. *R.macgregoriae x zoelleri*, which both belong to the same subsection and series, and both have typical butterfly-pollinated flowers. But what about the hybrids between different flower types, belonging to different subsections, and normally with different pollinators? e.g.

R.macgregoriae (butterfly) x *cruttwellii* (moth)
R.macgregoriae (butterfly) x *dielsianum* (bird)
R.aurigeranum (butterfly) x *konori* (bat)
R.konori (bat) x *herzogii* (moth)
R.culminicolum (bird) x *multinervium* (moth).

Of course the probable answer is that the pollinators do not always stick to their own type. If a butterfly-pollinated species is growing next to a bird-pollinated species, the butterfly will probably visit the other type also. But

perhaps not vice-versa? It is doubtful, for instance, that a bat would visit any other than a bat-pollinated species. It is also unlikely that a moth would visit an unscented bird or butterfly species. It probably would not notice it.

But there are some puzzles: e.g. the 'bat-moth' hybrid of *R.konori x herzogii* and the 'bird-moth' hybrid of *R.culminicolum x multinervium.*

Another puzzle is that where the three species, *R.macgregoriae, R.zoelleri* (both butterfly types) and *R.dielsianum* (bird) grow abundantly together, as at Litipinaga near Lufa (E.H.P.), the first two freely hybridize with each other, and so do the first and last, but *R.zoelleri* never seems to mate with *R.dielsianum*. Though I have not recently seen this cross, nor has it been recorded, I have an old photograph, taken in 1966 of something which looks very much like it from the Unggae (E.H.P.). The two parents are common and frequently grow together, so it should occur.

A number of artificial hybrids have been created in Australia between P.N.G. species and between these and West Irian species, the Australian *R.lochiae*, and other *Vireya* Rhododendrons. Some of these are very beautiful and are sold as nursery plants in Australia. However all attempts to cross Vireyas with other sections, e.g. to produce more hardy plants with the beautiful colours and unusual forms of Vireyas, have so far failed. There seems to be a genetic barrier between sections (though not between subsections).

1. Rhododendron (hybrid) *macgregoriae* x *dielsianum* Lufa road, E.H.P. c1700m.

2. Rhododendron (hybrid) *macgregoriae* x *zoelleri* Litipinaga. E.H.P. c1700m.

The Colour and Shape of Hybrids

When there is a union of two flower-types, both colour and shape are intermediate, as one would expect. This also extends to the habit, stem, leaves and scales, and indeed all characters. The actinomorphy of *R.macgregoriae* seems dominant over the zygomorphy of *R.dielsianum* and *R.rarum*. The hybrids have completely regular flowers. In *R.macgregoriae x cruttwellii* the tube, though long, becomes straight. On the other hand in the *R.konori* (pink form) x *herzogii* hybrid the zygomorphy was kept. In the

aurigeranum x konori (white form) the shape was almost exactly intermediate between the open 'butterfly' shape of *R.aurigeranum* and the narrower 'bat' shape of *R.konori*.

The colours are nearly always exactly intermediate, e.g. the yellow of *R.macgregoriae* with the rather mauve-pink of *R.dielsianum* gives a beautiful shade of salmon. *R.macgregoriae x cruttwellii* (white), on the other hand gives a cream, (as far as I can remember the scent was lost). The remarkable rose-red tubular-flowered plant, which has turned up at Mt. Gahavisuka, appears to be a cross of *R.culminicolum* (deep red) with *R.multinervium* (white). If so the red has strongly predominated.

Much more could be said about these combinations, but these examples show how confusing the hybrid flowers must be to the pollinators, as they do not conform to the types.

3. Rhododendron (hybrid) *macgregoriae* x *rarum* ? Mt. Gahavisuka E.H.P. 2000m.

4. Rhododendron ?
Possibly hybrid between R. *multinervium* and R. *culminicolum*. Mt. Gahavisuka E.H.P. 2000m.

Hybrid Swarms and Evolution

In certain places, such as Litipinaga, hybrids are present in great quantities, sometimes nearly as frequent as the parents. The older plants seem to be roughly the same age, but there are also many small seedlings, which appear to have the leaf characters of the hybrids. There is also some variation in the flowers, some approaching one parent more nearly and others the other, with many in between. This applies to shape, size and colour. There is no doubt too that the hybrids set seed, though whether this is viable remains to be seen. The abundance of seedlings suggest that it is. In this case one might

say that the hybrid is perpetuating itself and is virtually a new species. The great variation, the local occurrence of so many species, and the high degree of endemism suggests that the genus Rhododendron in P.N.G. is in a rapid state of evolution.

The so-called species *R.tuba*, Sleumer, discovered by me on Mt. Dayman, has been proposed as being a hybrid between *R.rhodoleucum*, Sleum. and *R.carringtoniae*, Sleum. I personally think its second parent is more likely to be *R.cruttwellii*, Sleum., as that grows nearby, and fits better the shape of *R.tuba*'s flowers. Other 'species' may also be, or have been derived from hybrids.

Some 'Mystery' Plants

There are one or two 'mystery' Rhododendrons, which I have not been able to identify, and which may be hybrids or species.

(a) 'Birat Red' This is similar to some forms of *R.zoelleri*, but with rougher leaves and bright scarlet flowers. It could be a variety of *R.zoelleri* or a hybrid, but if so with what? It grows near Birat in the Milne Bay Province. (b) 'Gahavisuka 121' Similar to *R.maius*, (J.J.S.) Sleum., but atypical. A small tree with beautiful pink and white tubular scented flowers (moth-pollinated). (c) 'Gahavisuka 122' A quite distinct plant with bright pink tubular actinomorphic flowers with a straight tube. I have only seen one adult plant. It must be either a hybrid (but of what parents?) or a new species. These last two plants occur in Mt. Gahavisuka Provincial Park, and I have not seen them elsewhere.

Conclusion

There is a lot of natural hybridization among the Rhododendrons of Papua New Guinea. Some of the hybrids seem to be fertile, and may be becoming settled species. Some of our described species may have started as, or may still be, hybrids. This all points to the genus *Rhododendron* being in a rapid state of evolution in P.N.G. This is confirmed by the high degree of endemism,

both locally and nationally (close on 99%). There are almost certainly more species waiting to be discovered in remote areas. The conservation of rare species and hybrids is greatly to be desired.

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