Studies on Orchidaceae Alkaloids. XXX.* Investigation of Fourteen *Phalaenopsis* Species. A New Pyrrolizidine Alkaloid from *Phalaenopsis equestris* Rchb.f.

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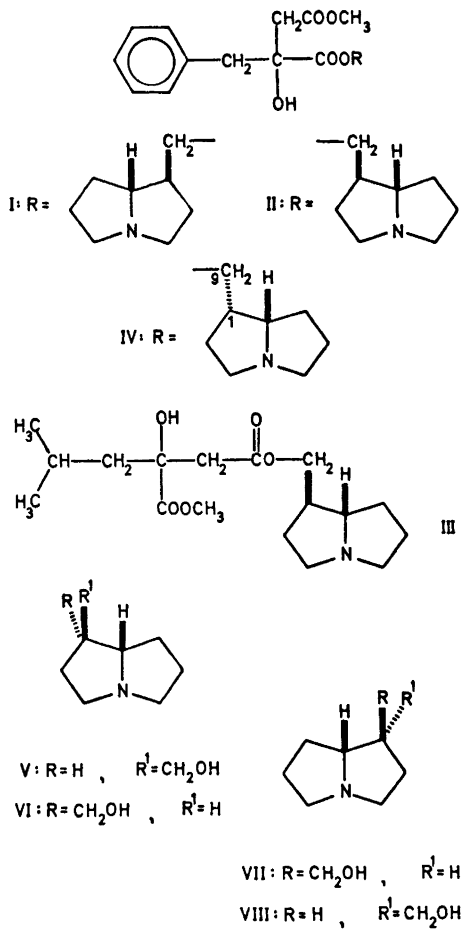
Previous studies on alkaloids from *Phalaenopsis* species have led to the discovery of phalaenopsine La** (I, from *Ph. mannii* Rchb.f.[2]), phalaenopsine T** (II, from *Ph. amabilis* Bl.[2]) and cornucervine (III, from *Ph. cornu-cervi* Rchb.f.[3]). In this communication we report the investigation of fourteen other *Phalaenopsis* species from one of which, *Ph. equestris* Rchb.f., a new alkaloid, phalaenopsine Is, has been isolated (IV, Is = isoretronecanol). From its NMR and mass spectra, GLC retention time (longer than that of I and II), and specific rotation ($[\alpha]_D^{22} - 42°$, *c* 1.5, ethanol) it is evident that the constitution of the alkaloid is monomethyl (+)- or (−)-2-benzylmalate esterified with isoretronecanol (VI). Its mass spectrum is indistinguishable from that of I, but its NMR spectrum differs in the coupling constant between the hydrogens at C-1 and C-9 (see formula IV). The coupling constant, $J = 7.5$ Hz, exceeds that of I, $J = 6$ Hz. The acetate of the enantiomeric pyrrolizidine carbinol lindelofidine (VIII) also shows the higher value, $J = 8$ Hz.

The alkaloid fraction obtained from another batch of *Ph. equestris* showed two peaks on GLC (area ratio 36/64). The retention times were the same as those of phalaenopsine La and phalaenopsine Is, respectively. Both compounds gave mass spectra identical with that of I. The specific rotation of the alkaloid mixture ($[\alpha]_D^{23} - 26°$) is consistent with a mixture of 36 % phalaenopsine T and 64 % phalaenopsine Is. Acid methanolysis yielded (−)-dimethyl 2-benzylmalate with approximately the same specific rotation ($[\alpha]_D^{22} - 9.4°$) as that obtained previously [2] for this compound ($[\alpha]_D^{22} - 9.7°$), and an amine fraction showing two peaks on GLC (retention times were the same as those of VII and VIII) with approximately the same area ratio (40/60) as that observed for the alkaloid mixture. The amine mixture was purified using a simplified reineckate procedure.[4] TLC and GLC–MS together with the specific rotation of the mixture ($[\alpha]_D^{23} - 42°$) indicated that the amines were trachelanthamidine [2] (V, 40 %, $[\alpha]_D - 15°$) and isoretronecanol [5] (VI, 60 %, $[\alpha]_D - 66°$). For lindelofidine (VIII), the enantiomer of VI, the value $[\alpha]_D + 79°$ has been reported.[6] A resolved sample showed $[\alpha]_D + 72°$.[7] Of the four natural stereoisomers V – VIII isoretronecanol has, to our knowl-



*For number XXIX in this series, see Ref. 1.

** Previously spelled phalaenopsin.

Table 1.

	Supplier	ph.La I		ph.T II	cornu-cervine III	ph.Is IV	$[\alpha]_D$ of alkaloid
Ph. amabilis [2]	d			+			−15°
Ph. amboinensis	g	+					+9.3°
Ph. aphrodite	d			+			−13°
Ph. cornu-cervi[3]	a				+		−4.3°
Ph. equestris	d					+	−42°
Ph. fimbriata	g			+			−12°
Ph. gigantea	e	−		−	−	−	
Ph. hieroglyfica	d	+	or	+			
Ph. lindenii	d	−		−	−	−	
Ph. lueddemanniana	d	+	or	+			
Ph. mannii [2]	b	+					+10°
Ph. sanderiana	d	+		+			+2.3°
Ph. schilleriana	d	+					+10°
Ph. stuartiana	d	+		+			−7.7°
Ph. sumatrana	c	+					+6.6°
Ph. violacea	c	+	or	+			
Kingiella taenialis [11]	b	+					
Doritis pulcherrima	f	+	or	+			

a. Bangkrabue Nursery, Bangkok, Thailand.
b. Chandra Orchid and Bulb Nursery, Kalimpong, India.
c. Dourado Medical Hall, Ipoh, Malaysia.
d. Fermin Orchids and Ornamentals, Manila, Philippines.
e. E. V. Lin and Co., Singapore.
f. Sakdi Sri Nursery, Bangkok, Thailand.
g. Simanis Orchids, Lawang, Indonesia.

edge, been isolated from natural material only once before.[5]

Isolation of a mixture of diastereomeric pyrrolizidine alkaloids from one species has been reported [4,8] and also the isolation of different alkaloids from different populations of the same species.[9]

The alkaloid material isolated from *Ph. sanderiana* Rchb.f. was identical on GLC−MS with I and II. However, the specific rotation ($[\alpha]_D^{22}$ +2.3°) differed from both that of I (+10°) and that of II (−15°). The sample of 1-acetoxymethylpyrrolizidine obtained after methanolysis, acetylation with ketene and purification by preparative GLC ($[\alpha]_D^{22}$ +2.5°) differed in optical rotation from (+)-*exo*-1-acetoxymethylpyrrolizidine ($[\alpha]_D$ +15°), but the rotation of the dimethyl 2-benzylmalate ($[\alpha]_D^{22}$ −9.9°) was approximately the same as those values obtained previously for this compound ($[\alpha]_D$ −9.4°; −9.7°). This means that a mixture of the diastereomeric alkaloids I and II was isolated from the plant material.

The chromatographically pure (TLC, GLC) alkaloid material from *Ph. stuartiana* Rchb.f. showed $[\alpha]_D^{22}$ −7.7°. Methanolysis afforded dimethyl 2-benzylmalate having $[\alpha]_D^{22}$ −8.7, and an amino alcohol which after acetylation showed $[\alpha]_D^{22}$ −8.5°. Hence, here II was the major component of the mixture of I and II.

Other pyrrolizidine alkaloids have been found partially racemic. A 28/72 mixture of (+)- and (−)-1-methylenepyrrolizidine has been isolated from *Crotalaria anagyroides*.[10]

I has been isolated from *Ph. schilleriana*, *Ph. amboinensis*, and *Ph. sumatrana*. In the latter case the alkaloid gave a different specific rotation, ($[\alpha]_D^{22}$ +6.6°), but as the methanolysis products showed their normal rotations, a mixture of I and II was excluded. II has been isolated from *Ph. aphrodite* and *Ph. fimbriata*. I or II (or a mixture of them) has been detected (GLC−MS) in extracts from *Ph. esmeralda* (=*Doritis pulcherrima*), *Ph. lueddemanniana*, *Ph. violacea*, and *Ph. hieroglyfica*.

However, the presence of alkaloids, epimeric to I and II in the 2-benzylmalate part of the molecule, can only be excluded safely by identification of the ester obtained in the methanolysis. We have not succeeded in detecting any phalaenopsine in extracts from *Ph. gigantea* or *Ph. lindenii* (only one attempt was made).

It is noteworthy that whereas the configuration of the amino alcohol part of phalaenopsine varies, the 2-benzylmalate residue has had the same absolute configuration (still unknown) in all hitherto methanolysed alkaloid samples.

Experimental. The suppliers of the plant material are given in Table 1. Isolations and methanolyses of the alkaloids as well as GLC and NMR measurements were performed as previously described.[2,3] Analytical GLC on V–VIII and their acetates, however, was carried out using a 20 % rather than a 3 % SE-52 column. Mass spectra were measured on an LKB 9000 instrument equipped with a GLC inlet system (2.8 m 1 % SE-30 for compounds I–IV and 2.8 m 20 % SE-52 for compounds V–VIII and their acetates). Specific rotations were measured in ethanol, *c* 1–3.

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Synthesis and Partial Resolution of 7-Carboxy-3,3′-spirobi(3-selenaphthalide)

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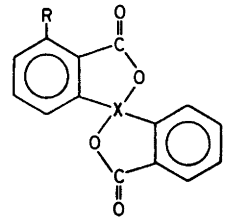
It is known that benzophenone-dicarboxylic acid is easily transformed into its anhydride,[1] which is assumed to be a dilactone (I).



I: X=C, R=H
II: X=Se, R=H
III: X=Se, R=COOH

A selenium analogue (II) has been reported by Lesser and Weiss,[2] and Agenäs and Lindgren [3] have recently synthesized an analogous aliphatic spiro-selena-dilactone.

As this ring system is chiral, a good proof for its formation would include the separation of a compound, with this ring structure, into its optical antipodes. To resolve this type of compound by general methods, a basic or acidic substituent has to be introduced into the ring system. Thus, in this paper the synthesis and partial resolution of 7-carboxy-3,3′-spirobi(3-selenaphthalide) are briefly reported.

The 7-carboxy group was introduced in the ring system by diazotizing the amino group of 3-amino-phthalic acid hydrochloride and by reacting the resulting diazonium salt with sodium diselenide. The organic diselenide was reduced with sodium formaldehydesulfoxylate (rongalit) in dilute ammonia. To the reaction mixture was added 2-iodo-benzoic acid and copper powder. This mixture was heated in an autoclave for 5–6 h at 180–190°. Upon acidification of the reaction mixture the 2,3,2′-tricarboxy-diphenyl selenide was