ATTI ACCADEMIA NAZIONALE DEI LINCEI

CLASSE SCIENZE FISICHE MATEMATICHE NATURALI

RENDICONTI

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Biogenetic correlations of anthranoids in Vismia genus

Atti della Accademia Nazionale dei Lincei. Classe di Scienze Fisiche, Matematiche e Naturali. Rendiconti, Serie 8, Vol. **65** (1978), n.6, p. 302–306.

Accademia Nazionale dei Lincei

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Chimica organica. — *Biogenetic correlations of anthranoids in Vismia genus.* Nota di Giovanni Battista Marini–Bettòlo, Franco Delle Monache, Marielena Marquina Mc Quahe (*), presentata (**) dal Corrisp. G. B. Marini–Bettòlo.

RIASSUNTO. — Lo studio dei componenti colorati delle bacche di alcune specie di *Vismia* (Guttiferae) dell'America tropicale, ha permesso di stabilire la struttura di una serie di nuovi composti derivati dal tetraidroantracene contenenti una o più catene preniliche.

Questi componenti si possono dividere in due gruppi a seconda della posizione dell'anello aliciclico, al primo appartengono i Vismioni e, al secondo la Vismina, le Ferruginine e l'Harunganina.

Sulla base del confronto tra queste strutture e sulla loro distribuzione nelle specie è stata avanzata un'ipotesi biogenetica che riconduce queste sostanze ad un comune precursore.

In a previous paper [1] we reported the isolation from the berries of *Vismia baccifera* var. dealbata L. Pl. (Guttiferae) of a number of sesquiterpenes i.e. (—) copaene, (+) selinene (—) isocaryophyllene, (—) β–curcumene, (—) α–curcumene, α–humulene, as well of two coloured products, Vismione A and B.

We now report the results of research on other *Vismia* species from tropical America which enable us to formulate some hypotheses on the biogenesis of these substances. (Table I).

The structure of Vismione A (III, R = Ac) and Vismione B (IV) has been established by chemical, spectroscopic and X–ray procedures [2, 3]. It has been shown that it can be related to the structure of chromomycin [4], an antitumoral antibiotic isolated from the metabolites of *Streptomyces griseus* and to the anthracyclines (adriamycin). All products isolated [5–7] from the above reported *Vismia* species are derived from the anthracene skeleton with a different degree of unsaturation.

A common feature of these products is their high chelating property. We propose the name anthranoids, in analogy with flavonoids, for the natural products derived from the skeleton of anthracene, independently of their unsaturations and substitutions i.e. anthranols, anthraquinones, anthrones, tetrahydroanthracenes, etc.

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(**) Nella seduta del 16 dicembre 1978.

TABLE I.

Composition (*) *of Vismia species*

	Deacetyl-vismione A III (R=H)	Vismione A III (R=COCH$_3$)	Vismione B IV	Vismin V	Ferruginin A VI	Harunganin VII	Ferruginin B VIII	γ-Hydroxy ferrug. A IX	γ-γ′ Dihydroxy ferrug. A X	Ferruan-throne
V. baccifera (3) var. dealbata		+++	++							
V. lindeniana (6) . .	+++	+++	++		+			+++		
V. falcata (6)	++	++	+		+			+++	+	
V. baccifera (5) var. ferruginea		+	+	+	+++	+++	++	+		++
V. macrophylla (6) .				+++	+++	+	++			+
V. guaranirangae (7).					+			+++	+	
V. guianensis (7) . .					+			+++	+++	
m. p.	160–5° C dec	140–1° C	200–2° C	161–4° C	168–70° C	181–5° C	110–4° C	82–4° C	106–10° C	166–70° C
Elemental composition	$C_{21}H_{24}O_5$	$C_{23}H_{26}O_6$	$C_{21}H_{22}O_5$	$C_{25}H_{28}O_4$	$C_{30}H_{36}O_4$	$C_{30}H_{36}O_4$	$C_{30}H_{36}O_4$	$C_{30}H_{36}O_5$	$C_{30}H_{36}O_6$	$C_{30}H_{36}O_4$
M$^+$	356	398	354	392	460	460	460	476	492	460
EtOH . . . . λ max	242, 291 330 sh, 410	243, 291 335 sh, 410	241, 278 410	242, 319 335 sh, 408	243, 321 412	242, 323, 412	242, 260 sh, 321, 414	245, 322, 337 sh, 410	245, 322, 337 sh, 410	240, 256, 275, 313, 365
[α]$_D$	—	+ 54°	+ 24°	—	—	—	—	+ 59°	— 58°	—

(*) It should be mentioned that most probably the ratio of the different anthranoids present in *Vismia* sp. may vary according to the season and to the geographic location of the plant. We have in effect established that from two samples of *Vismia baccifera var. ferruginea* collected in Venezuela and in Colombia, respectively, the ratio between Harunganin and Vismin is completely reversed.

In Table I are reported the products isolated from the genus *Vismia*, which are all new except harunganin (found in a plant from Madagascar, *Harungana madagascariensis* (Guttiferae) [8]), with their physical and spectroscopical characteristics.

The structures of these products are reported in Fig. 1. They can be all related to two main types represented by Deacetyl-vismione A (III, R = H) and Vismin (V), respectively, and their similarity suggests a common progenitor.

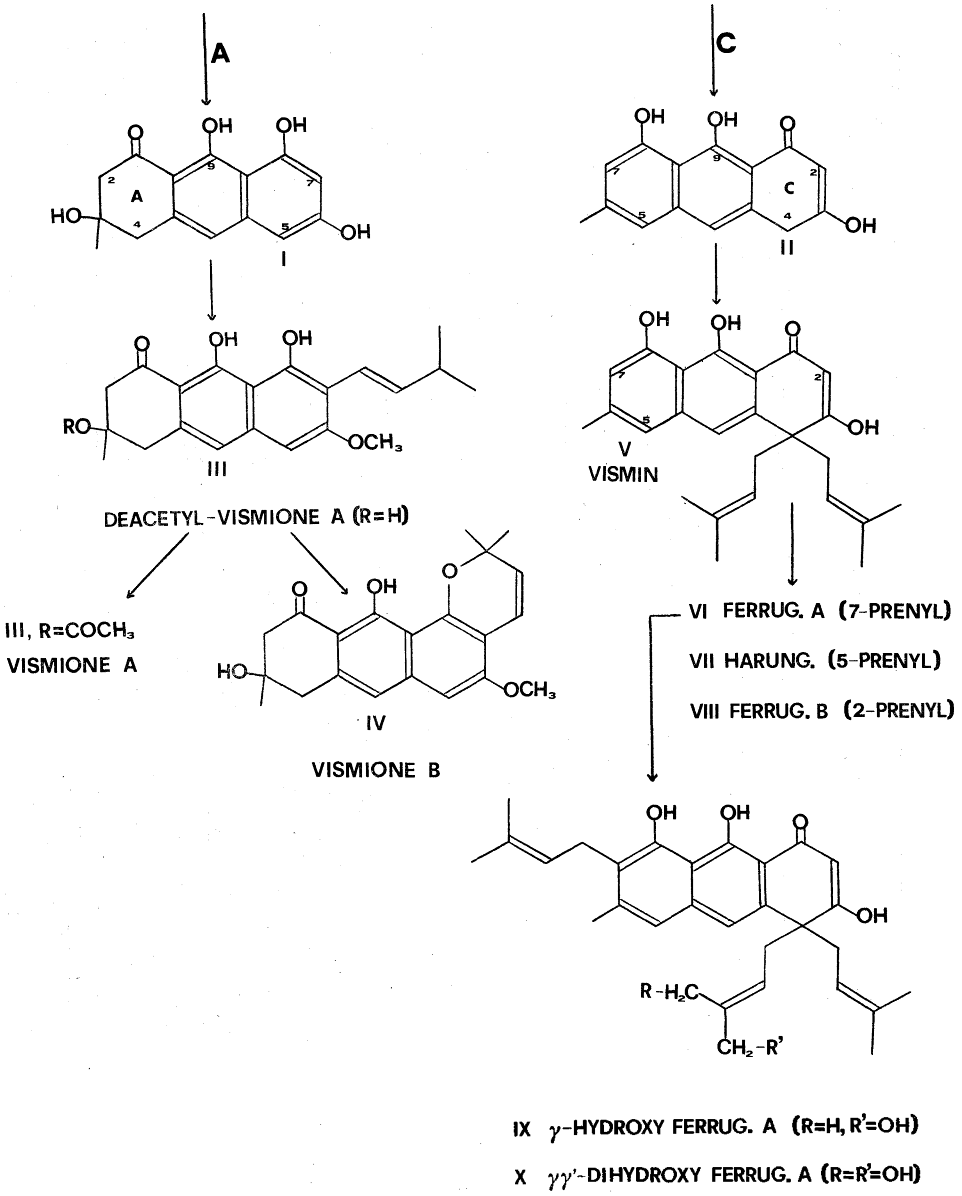

Fig. 1.

It has been demonstrated by Birch [9] that polyhydroxyanthracenes are formed in plants via the acetate-malonate pathway from a hypothetical polyketide intermediate (1).

We now propose the following scheme (Figs. 2 and 1) for the pathway of the biogenesis of these products.

The polyketide acid gives, by intramolecular aldolic condensation and decarboxylation, a hypothetical alicyclic derivative which by loss of two molecules of water originates another intermediate.

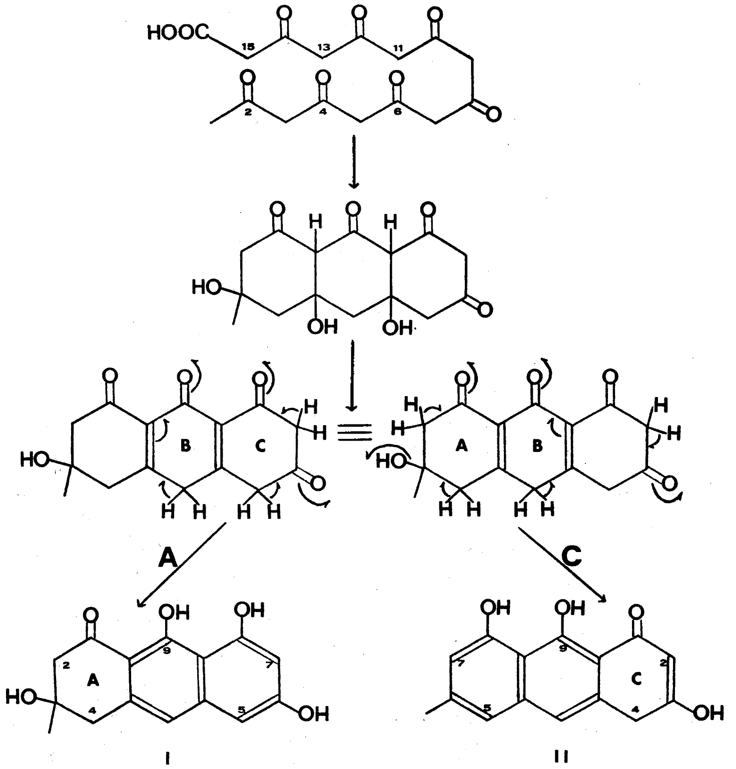

Fig. 2.

From the latter we may argue that two different routes are possible: the first one leads to the aromatization of rings B and C (Route A), giving rise to a ketonaphthodiol (I), the second (Route C) implies the aromatization of rings A and B and yields the ketonaphthodiol (II). Both I and II are the precursors, respectively, of Vismiones and Vismin.

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(1) The shikimic-mevalonate pathway could also be proposed for the first stages of this biosynthesis, mainly because of the presence of a CH_3 in position *3* or *6* in the two series, respectively, but in the case of all the above products it is not easy to justify the presence of OH groups in *1*, *3*, *8*, *9* or *1*, *3*, *6*, *8*, *9*.

In effect Deacetylvismione A is obtained by C-prenylation of I in *7*, followed by isomerisation of the double bond in the prenyl chain.

By acetylation or cyclodehydratation Vismione A (III, $R = COCH_3$) and B (IV) are formed from the latter.

On the other hand, ketonaphthodiol (II) undergoes a double C-prenylation in *4* and gives rise to Vismin (V). Further prenylation of Vismin in the positions *7*, *5* and *2* originates Ferruginin A (VI), Harunganin (VII) and Ferruginin B (VIII), respectively.

By β–oxidation to the double bond in the prenyl chains γ–Hydroxy–ferruginin A (IX) and γ–γ′–Dihydroxy–ferruginin A (X) are obtained from the Ferruginin A.

Although the high reactivity of position *9* of the above products may suggest an easy dimerization in compounds of the hypericine type [10] from *Hypericum perforatum* (Hypericaceae), a species belonging to the family of *Guttiferae*, no dimeric anthracene has so far been found in the genus *Vismia*.

The finding of the above substances belonging to two different groups in a single plant i.e. *Vismia falcata*, *Vismia baccifera var. ferruginea*, *Vismia lindeniana*, indicates that both pathways (A and C) are to be considered in the biogenesis of *Guttiferae*.

Furthermore, the occurence of these products in different species may be of help in establishing the chemotaxonomy of this family.

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