# Naturally Occurring Non-Alkaloidal Phenanthrenes

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يتضمن هذا البحث استقصاء لما تم فصله من مركبات الفينانثرينات وثنائية البنزيل غير القلويدية من النباتات المختلفة. وقد استثني من هذه المركبات تلك التي تحتوي نتروجين حيث تدرج تحت أشباه القلويدات. كما يتضمن البحث على ذكر للخواص الميكروبيولوجية لهذه المركبات.

In this review, an attempt has been made to list all non-alkaloidal phenanthrenoids which have been isolated from the different plant families. The antimicrobial activities of those compounds is included.

## Introduction

Phenanthrene derivatives have been isolated from many families of higher plants. However, large number of these naturally occurring compounds containing nitrogen such as aporphine alkaloids, simple 1-aminoethylphenanthrenes and Phenanthroindolizidine alkaloids. Such nitrogen compounds are regularly reviewed under the heading of alkaloids. Thus, the purpose of the present review is to list all naturally occurring non-alkaloidal phenanthrenoids from 1969 up to date in addition to aristolochic acids which are in fact derivatives of 10-nitrophenanthrene-1-carboxylic acid.

## Phenanthrenoids

As mentioned above, natural Phenanthrenoids encountered in this review are only the non-alkaloidal constituents. Most of these compounds bear hydroxy, methoxy or methylenedioxy substituents as it could be noted from Figures **1-7.** Literature survey revealed that phenanthrenoids have been isolated from several species of twelve plant families (Table-1). However, species of Dioscoreaceae and Orchidaceae constitute the major source of this class of natural compounds.

In 1988, the number of naturally occurring non-alkaloidal phenanthrenoids was estimated to be about 40[58] compounds. Since then, the number of these compounds have increased rapidly to about 130 by the end of 1993. In order to facilitate discussion through the text we are grouping these surveyed compounds to the following: **i)** simple phenanthrenes which include those having hydroxy and methoxy groups, **ii)** Phenanthropyrans, **iii)** alkylated phenanthrenes, **iv)**phenanthroquinones, **v)** aristolochic acid derivatives and **vi)** biphenan-threnoids.

**Simple phenanthrenes.** 64 compounds of simple phenanthrenes and 9,10-dihydro derivatives have been isolated from various natural sources (Table 1, Figures 1 and 2). 2,6,7-Trimethoxyphenanthr-4-ol **(20)** as well as **102** and **103** were first isolated in 1969 from ***Tamus communis*** belonging to Dioscoreaceae [21] while the first representative of 9,10-dihydrophenanthrenes was orchinol **(44)** which is produced by ***Orchis militaris*** [33] as a defense substance under the influence of certain morbific agents. Phenanthrene itself **(1)** has recently been isolated from ***Pterolobium hexapetallum*** of Leguminosae (Table-1) and this is its only occurrence in Nature [1]. Similarly, up to date, compound **2** (Fig. 1) is also the only example in Nature of monosubtituted phenanthrenoid, although an analogue of **2** with an additional $CH_2$ was identified from the same natural source [2]. However, the exact location of the side chain in **2** and its analogue could not be ascertained but the MS fragmentations of both compounds suggested it to be at C-2 or C-3.

The Trioxygenation pattern of the isolated phenanthrenes is represented by compounds **3-5** obtained from ***Papaver somniferum*** (papaveraceae) and **6** from ***Bletilla striata*** **(Orchids)** (Table 1). As it could be seen from Fig. 1, the remaining phenanthrenes are tetra-, penta- and hexa-