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39. *Mandragora*—taxonomy and chemistry of the European species

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Confusion in the literature concerning the nomenclature of the genus *Mandragora* has implied that a number of European species exist. These investigations suggest that only two species, *M. officinarum* L. and *M. autumnalis* Bertol. can be accepted and their morphology is described. The structure of the roots and rhizomes* of the two species has shown them to be indistinguishable. The chemistry of the roots and rhizomes of the two species is also similar; they contain tropane alkaloids and both tropic and tiglic esters, the significance of which in the chemotaxonomy of the Solanaceae is indicated. The roots and rhizomes also contain β -methylesculetin, sitosterol and free sugars.

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TAXONOMY

European species of *Mandragora* have a long history of usage in medicine, and many legends associated with the plants have arisen from the characteristic anthropomorphic appearance of the roots and rhizomes. There has been considerable confusion in the nomenclature of the genus and by choosing different and varying characters such as time of flowering, colour of the corolla and the size and shape of the fruits as taxonomic criteria, botanists in the past have given the impression that a number of species exist.

The Ancients distinguished two main European species which they called "female" and "male" Mandrakes. The female form is described by Dioscorides (see Gunther, 1933) as having "narrower and longer leaves than lettuce, of a poisonous and heavy scent . . . and amongst them ye apples like service berries pale, of a sweet scent, in which is ye seed as of a pear; ye roots two or three of a good bigness, wrapped within one another, black according to outward appearance, within white and of a thick bark". The male species he described as having leaves which are "greater, broad, smooth as of beet but ye apples twice as big—saffron in colour, sweet smelling . . . root greater and whiter . . .".

Parkinson (1629), also described Mandrake as being separated into two kinds,

* Technically, taproots (*Eds*)

the male and female, and his descriptions of the leaves and fruits of the two species are similar to those given by Dioscorides. In addition, he gives details of the flowers, those of the male Mandrake "rising up from the middle, among the leaves . . . every one upon a long slender stalk standing in a whitish green husk consisting of five pretty large round pointed leaves, of a greenish white colour"—while those of the female Mandrake are similar but "of a bluish-purple colour". It is interesting to note that he did not distinguish between the two species on the basis of the colour of the roots, but stated that both kinds were "black without and white within". Parkinson also refers to a second form of the male Mandrake which he describes as having leaves of a more greyish green colour and somewhat folded together. He also writes "The male flowers in March and the fruit is ripe in July. The female if it is well preserved flowers not until August or September, so that without extraordinary care we never see the fruits thereof in our garden".

Parkinson first drew attention to one character which was the cause of considerable confusion in the identification of the two types. It had previously been suggested that the male Mandrake had globose fruits and the female pear-shaped or oblong fruits. However, Parkinson states that the female plant has "small round fruits or apples and not long like a pear".

The first attempt at a botanical classification of *Mandragora* was that of Tournefort (1719). A fuller description of the genus was published by Jussieu (1789) in which it was placed with *Atropa* in the order Solaneae. This link with the genus *Atropa* is reflected in some of the names given to *Mandragora* at that time. In *Species Plantarum* (1753) Linnaeus had described a single species of *Mandragora*, *M. officinarum*, but in successive editions of the work (1762, 1764) this was changed to *Atropa acaulis*. Woodville (1794), applied the name *Atropa Mandragora* to the same plant.

Sprengel (1825), who edited the sixteenth edition of Linnaeus' *Systema Vegetabilium*, named two species of *Mandragora*, *M. vernalis* Bertol. and *M. autumnalis* Bertol. He thus referred to the work of Bertoloni (1824) who described two species, *M. vernalis* and *M. officinarum*, and claimed that the latter species was the same as that earlier described by Linnaeus. Bertoloni stated that *M. vernalis* Bertol. was equivalent to the species which he had previously named *M. officinalis* Bertol., and *M. officinarum* Bertol. was the same as *M. autumnalis* Bertol. Sprengel preferred to use the specific name "*autumnalis*" which Bertoloni had originally given to the second species rather than the later name "*officinarum*".

In a later work, Bertoloni (1835) described a third species of *Mandragora* which he called *M. microcarpa* Bertol. This he characterized as having smaller, more globose fruits than *M. officinarum* Bertol. and was the form known as "*Mandragora minore*" in Italy and "*petite Mandragora*" in France. The existence of this additional species was supported by De Candolle (1852) who distinguished *M. microcarpa* Bertol. from the other species by the smaller size of the underground parts. Cesati, Passerini & Gibelli (1867) also described two autumn flowering species, *M. officinarum* L., which had an ovoid-oblong fruit equal in length to the calyx and flowered from September to October in Calabria and Sicily, and *M. microcarpa* Bertol., which had a smaller, globose fruit, shorter than the calyx and flowered from October to November in Sardinia and Napoletano. Von Heldreich (1886) again recognized two autumn flowering species which he called *M. autumnalis*

Spreng. and *M. microcarpa* Bertol. He maintained that, whilst in *M. autumnalis* the leaves and flowers develop simultaneously, the first flowers of *M. microcarpa* Bertol. "arise and develop from the middle of September, in dense clusters; the plant has no leaves or at the most incompletely mature, small leaves. These subsequently develop little by little, though they never become very large—they are broader and shorter even than in *M. autumnalis* Spreng. . . . The flowers are the largest and most beautiful of the genus, a very beautiful violet, 1½ inches long". His description of the fruit is similar to that of previous workers.

More recently, Pahlina (1939) also distinguished two autumn flowering species growing in Portugal, *M. autumnalis* Spreng. and *M. (β) microcarpa* Bertol., each with characteristics of the fruits similar to those given by Cesati *et al.* (1867) for the Italian species.

Other workers have suggested that *M. microcarpa* Bertol. should be considered as a variety of *M. autumnalis* and not as a distinct species (Arcangeli, 1894; Fiori & Paoletti, 1908; Fiori, 1929; Maugini, 1959).

It is now generally considered that *M. microcarpa* Bertol. is not sufficiently different from *M. autumnalis* Bertol. to be regarded as a distinct species or variety. This view was held by Moris (1858) who named *M. officinarum* L. as being synonymous with *M. autumnalis* Bertol., *M. microcarpa* Bertol. and *Atropa mandragora* L. Parlato (1883) also proposed only two species, uniting *M. microcarpa* Bertol. with *M. autumnalis* Bertol. In addition, he chose not to use the name *M. officinarum* L. for the spring flowering species because he maintained it was not clear to which species Linnaeus had given this name and its use had consequently led to considerable confusion.

Von Heldreich (1886), in addition to accepting *M. microcarpa* Bertol. as a true species, also recognized a fourth European species which he called *M. haussknechtii* Heldr. This species, he claimed, was more clearly related to the autumn flowering species although it flowered in winter and spring. It had large, violet flowers and could be distinguished from *M. autumnalis* Bertol. by having longer leaves and fruits which were larger, more ovoid and waxy yellow in colour. He further claimed that Professor Haussknecht, after whom he had named the species, had found a hybrid between *M. vernalis* Bertol. and *M. haussknechtii* Heldr. (*M. hybrida* Hausskn. et Heldr.) which showed characters intermediate between the two parent species. He pointed out that such a hybrid could easily arise as *M. vernalis* Bertol. and *M. haussknechtii* Heldr. flower and fruit simultaneously over a long period.

The validity of von Heldreich's claims concerning *M. haussknechtii* was examined by Vierhapper (1915) and he was unable to confirm the hybrid nature of *M. hybrida* Hausskn. et Heldr. on examining the original specimen. Rather, he considered that *M. haussknechtii* and *M. hybrida* were more likely to be varieties of *M. officinarum* L. and not true species. Vierhapper did, in fact, suggest that four distinct taxa could be distinguished within the species *M. officinarum* L. as follows:

(1) an autumn flowering form found over the whole area of distribution of the species; this variety was equivalent to *M. autumnalis* Bertol.

(2) and (3) late spring flowering forms, of which one occurs in the western and the other in the eastern part of the areas in which the species is found; these are distinctly different from (1) although clearly closely related. The western form he

named *M. hispanica* Vierhapper and the eastern form he said was equivalent to *M. haussknechtii* Heldr.

(4) a form which flowers in autumn but occurs only in the centre of the area of distribution and is morphologically distinct; this form was equivalent to *M. femina* Gersault.

Vierhapper described the characters of his new species *M. hispanica* in detail, and claimed that it could be distinguished from the other varieties by the characters of the leaves. He also emphasized the differences in the flowering times amongst the four varieties. *M. femina*, he stated, flowered in September and October while *M. autumnalis* produced flowers and fruits from September through to February. Both *M. hispanica* and *M. haussknechtii* commenced their flowering periods in January and Vierhapper claimed to have collected samples of flowers and fruits of *M. autumnalis* at the same time as flowers of *M. hispanica*, in the same localities.

In addition to the four varieties of *M. officinarum* L., Vierhapper also recognized a true spring flowering species under the name *M. mas* Gersault (equivalent to *M. vernalis* Bertol.). He thus added considerably to the confusion in the nomenclature of the genus by maintaining that the plant described by Linnaeus as *M. officinarum* referred to the autumn flowering and not the spring flowering species as had been assumed by earlier workers.

Tercinet (1950) carried out an extensive investigation into the taxonomy of *Mandragora* and was unable to support the work of von Heldreich and Vierhapper. He decided that there were only two Mediterranean species and these he defined as follows:

"*Mandragora autumnalis* Bertol.—Female *Mandragora* (syn. *M. microcarpa* Bertol., *M. officinalis* Moris*, *M. officinarum* Bertol. but not Linnaeus, *M. femina* Gersault) which grows principally in S. Italy (where it has the name *M. femmina*), in Spain, Greece, Crete and Asia Minor. It is also found in North Africa, particularly Tunisia and Morocco."

"*Mandragora officinarum* L.—Male *Mandragora* (syn. *M. acaulis* Gaertn., *M. neglecta* G. Don, *M. officinalis* Miller but not Moris*, *M. praecox* Sweet, *M. vernalis* Bertol. *M. mas* Gersault), which grows in the same countries as the previous species but is more resistant to cold and can appear further north."

Tercinet thus agreed basically with Engler & Prantl (1897) and Lázaro & Ibiza (1921) who also had recognized only two Mediterranean species. Engler & Prantl, however, had assigned the authorship of *M. autumnalis* to Sprengel and not to Bertoloni because they considered *M. autumnalis* Bertol. to be synonymous with *M. microcarpa* Bertol. and, as they wished to stress that there was only one autumn species, by using the name *M. autumnalis* Spreng. they hoped to avoid confusion which might be caused by reference to the work of Bertoloni. Maugini (1959) supported Tercinet's use of the name *M. autumnalis* Bertol. but, like Parlatores, she advocated the name *M. vernalis* Bertol. for the spring flowering species in preference to *M. officinarum* L.

* The name *M. officinalis* was used by Miller (1768) for the species which he regarded as synonymous with *M. officinarum* L. His description is that of the spring flowering species. Moris (1827) recognized the existing name *M. officinalis* but the specimens to which he gave this name flowered in the autumn. Bertoloni (1824) on the other hand, specified that *M. officinalis* Bertol. is synonymous with *M. vernalis* Bertol. Hence Moris applied to the autumn flowering species the name that Bertoloni and Miller had given to the spring flowering species.

In the *Notulae Systematicae*, No. 13 for the *Flora Europaea*, edited by Heywood (1972), Hawkes recommends that the name *M. officinarum* L. should be retained as representing the type species of the genus.

Tercinet's classification includes reference to some of the variations noted by other workers, and he outlines the main characters of the two species as follows:

"*M. autumnalis* Bertol. thrives in shaded places, on river banks and it also sprouts up in stony habitats where conditions are sufficiently sheltered and irrigated. It is occasionally found around stone tombs in cemeteries. It flowers in autumn during October and November. Its root is long, fusiform, whitish within, blackish at the surface, entire or bifurcated and, in some, more or less similar to the lower part of the human body. The leaves are rather large, the margin obtuse at the apex, the base acute, a pale sea-green colour, shiny above, paler beneath, more or less bristling with hairs, and ciliate at the margin, with an elongated petiole. The flowers succeed each other over a long period in the plant and have reddish-green peduncles, enlarged and pentagonal in their upper region. The corollas are large, about 3 times as long as the calyx, pale violet in colour. The fruit is ovoid, obtuse, with a small elongated calyx which surrounds it. The colour of the fruit is yellowish-fawn at maturity and it has a very foetid odour.

"*M. officinarum* L. produces its leaves and flowers at the beginning of spring (March and April). Its root is similar to that of the female Mandragora, but larger and pale on the outside (ordinarily of a dirty white). The glabrous leaves are more uniformly large and diffuse a strong nauseous odour. The flowers are numerous, compact, on pale green peduncles, shorter than the leaves and hairy. The corolla is a whitish-green or slightly yellow. The outer side of the corolla is covered with hairs which, viewed under the microscope, present the appearance of masses having a swollen head, comprising about 15 cells and supported by a slender, 2 or 3 celled, uniseriate stalk. The fruits are much larger than those of the previous species, being as large as a small apple (pomme d'api—a particular species of small red apple called *malum Appiarum*), globose, glossy, yellow and extending well beyond the calyx. Certain authors in antiquity called *M. officinarum* L., because of this latter character, *Mandragora fructu rotundo* or *fructu majore*; in this case *M. autumnalis* Bertol. was known as *Mandragora fructu pyri*. Flahaut called attention to the fact that *M. officinarum* L. has an embryo which is much larger than that of other species of Solanaceae he had examined."

In *Flowers of Europe* (Polunin, 1969) *Mandragora* is represented by a single species, *M. officinarum* L., which is described as having violet flowers which appear in the spring and autumn. The accompanying illustration shows the characters of *M. autumnalis* Bertol. In a later work (*Flowers of S.W. Europe*, Polunin & Smythies, 1973) a similar illustration is included but the plant is here called *M. autumnalis* Bertol. (*M. officinarum*) and the reference to flowers appearing in the spring is omitted. It would seem that, if Tercinet's simplified classification were to be generally accepted, it would greatly assist in the identification of the Mediterranean species, as it is in *Flora Europaea*, Vol. 3.

ANATOMY

Apart from the brief reference to the microscopy of the hairs on the corolla included in Tercinet's description of *M. officinarum* L. given above, very little

detailed work on the anatomical characters of the two species has been carried out. Maugini (1959) described the structure of the roots, rhizomes* and leaves of *M. autumnalis* Bertol. but her account did not include drawings to illustrate the general histological features. In view of the confusion which exists in the identification of the European species, it seemed of interest to investigate in detail the microscopy of the two species in order to determine whether or not there were any histological features which could be used to distinguish between them. Work on the roots and rhizomes has already been completed (Berry & Jackson, 1976) and this has shown that, both morphologically and anatomically, there are no marked differences between those obtained from the two species. Roots and rhizomes of *M. officinarum* L. attain a larger size than those of *M. autumnalis* Bertol. but both frequently show the characteristic anthropomorphic development. Contrary to the descriptions given in the literature, the colour of the cork layers cannot be used to distinguish between the two species as all the specimens examined were pale greyish or reddish brown externally on the roots with darker brown on the rhizomes. A preliminary comparison of the leaves has indicated that *M. autumnalis* Bertol. has considerably more trichomes, especially on the upper surface, than *M. officinarum* L. and it is anticipated that similar differences may be detected when comparison of the histology of the flowers and fruits has been completed. It is hoped that these anatomical investigations will provide useful information which can be applied to the differentiation of the species and serve as additional criteria in the evaluation of any so-called varieties.

CHEMISTRY

In spite of the considerable interest shown in the Mandrake plant throughout the ages and the traditional use of the roots in herbal medicine, surprisingly little work has previously been published on the chemical constituents. Any information which was available could not always be evaluated satisfactorily because it was not clear on which species the work had been carried out. Ahrens (1889), for example, examined samples which he called Sicily, Venice and Trieste mandrake, the first of which he thought was equivalent to *M. vernalis*, but he did not attempt fully to authenticate his material. Hesse (1901) also analysed samples from Trieste which he stated were *M. officinalis* Miller, adding the note that "this is differentiated, to be sure, by Bertoloni into *M. vernalis*, *M. autumnalis* and *M. officinarum* but this distinction has not generally been remembered and considerable contradiction is often found". Staub (1942), investigated samples which he called *M. autumnalis* Spr. for non-alkaloid constituents, but for his work on the alkaloids he used a commercial sample of *Radix Mandragorae offic.* which he considered to be a mixture of *M. autumnalis* Spr. and *M. vernalis* Bertol. (Staub, 1962).

It therefore seemed appropriate to carry out a full investigation of the constituents of authenticated samples of *M. autumnalis* Bertol. and *M. officinarum* L. to determine whether or not any differences exist which could be used as an additional means of distinguishing between the two species. Because of the established use of the underground parts of the plants in medicine the investigations were carried out on roots and rhizomes.

* Technically taproots (*Eds*)

The results of an extensive investigation into the alkaloid constituents has shown the presence, in both species, of hyoscyamine, hyoscyne, cuscohyamine, apoatropine, 3 α -tigloyloxytropine and 3,6-ditigloyloxytropine. Belladonnine was also detected in the dried roots (Jackson & Berry, 1973). Work on the non-alkaloid constituents has confirmed the presence of sitosterol and β -methylesculetin and has demonstrated that four free sugars, namely rhamnose, glucose, fructose and sucrose are also present; similar results were obtained for both species. The occurrence of β -methylesculetin in the fruits of *Mandragora* species has been reported by Tercinet who suggested that this probably explained the legends about the 'glowing' of the fruits in the evening.

Although this work did not indicate any differences in the constituents between the roots of the two *Mandragora* species, it did yield information of considerable interest in the wider chemotaxonomic field within the family Solanaceae. *Mandragora* is placed by Wettstein (1897) in the tribe Solaneae which includes a number of genera in which the occurrence of tropane alkaloids has been established. Amongst these genera, however, there is only one other, namely *Scopolia*, in which the presence of both tropic and tiglic acid esters has been reported. On the other hand, within the tribes Daturae and Salpiglossideae, are included several other genera in which both types of esters occur. It is possible, therefore, that *Mandragora* and *Scopolia* can be considered as a chemotaxonomic subgroup linking the Solaneae with similar subgroups within the Daturae and Salpiglossideae.

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