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Interesting facts in our field.



Les mystères, Germaine Knecht 1976

PASSION FOR SCENTS

Musks in Perfumery

Natural Musk is an intensely smelling secretion of an abdominal gland ("musk gland") of the male musk deer (*Moschus Moschiferus* L.). This rare species lives solitarily in the Asian highlands (Central and East Asia like Tibet, Himalayas, etc.). Its secretion serves the purpose of finding a mating partner. For mankind musk has been associated with invulnerability, power and male potency for a long time. In some cultures this belief has persisted till today.

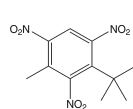
In the past the musk deer was killed to deprive it of its most valuable musk, a viscous brown liquid which becomes grainy after drying. Later, attempts were made to breed the animals in farms or to trap them in their natural habitat during the mating period and to obtain the secretion with the aid of a syringe. Fortunately, shortly before its definite extinction protection programs helped the musk deer to survive. In the past 20 years, the use of the natural musk for "medicinal" problems (i.e. potency, etc.) and in perfumery has decreased drastically and is, as a matter of fact, of no importance anymore. This is mainly due to the legal protection of this species, but also for the very high price of the genuine natural product and the fact that synthetic musks with similar olfactory properties and much lower prices have become available since the early beginning of the 20th century.

In perfumery musks have proven to be of greatest value. They normally exhibit a strong warm, sensual, velvety and long-lasting odor which makes them invaluable in perfumes, but also in fragrances for shampoos, fabric softeners, detergents, soaps and other products.

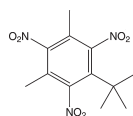
Synthetic musks are generally divided in three subgroups: nitromusks, polycyclic and macrocyclic musks.

Nitromusks

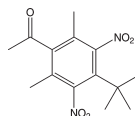
Nitromusks are artificial compounds, i.e. they are not produced in nature. The first member of this group has accidentally been discovered in 1888 by A. Baur¹. Baur was working on explosives (by nitration of organic compounds) and perceived the sweet musky odour of one (1) of his reaction products. He later found Musk Xylene (2), Musk Ketone (3) and Musk Ambrette (4), all of them nitration products of aromatic compounds. Musk Tibetene (5) and Moskene (6) are also members of this group but are of little commercial importance. Due to its photosensitivity² and neurotoxic effects³ Musk Ambrette may not be used anymore since years. Only Musk Ketone and Musk Xylene are still used, mostly in older perfumes.



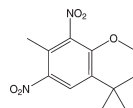
1 (547-94-4)



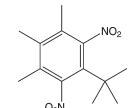
2 (81-15-2)



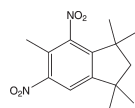
3 (81-14-1)



4 (83-66-9)



5 (145-39-1)

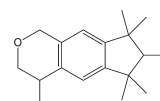


6 (116-66-5)

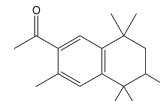
A number of disadvantages, e.g. the dangerous production of these compounds (over time many musk factories exploded) and the increasing availability and commercialization of the so-called polycyclic musks in the 60's led to a decreasing demand of this group of musks. Today, the use of nitromusks is highly undesirable since they are hardly biodegradable and therefore accumulate in nature. This is the same problem that polycyclic musks pose.

Polycyclic Musks

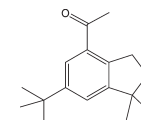
In the middle of the twentieth century the polycyclic musks have been developed. Quite a great number of musk-type components with an indane, tetraline or isochromane structure have been described in the scientific literature. But only few of them are of commercial and perfumistic interest. Compound 7 (HHCB, isochromane type) with its trade names AbbalideTM, GalaxolideTM, Musk 50TM, PearlideTM, AstrolideTM etc. and 8 (AHTN, tetraline type) with trade names FixolideTM, TetralideTM, TonalideTM, etc are by far the economically most important ones. Compound 9 (ABDI, indane type) with trade names CelestolideTM, CrysolideTM, etc and 10 and 11 are also members of this subgroup but are less frequently used. Compound 12 (VersalideTM) has not been used since many years due to its neurotoxic effects in animals⁴. 13-17 are some more polycyclic musks rarely used in perfumery.



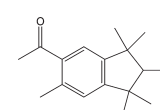
7 (1222-05-5)



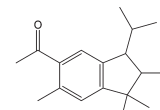
8 (1506-02-1)



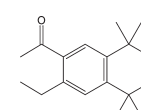
9 (13171-00-1)



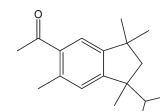
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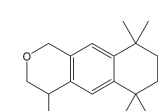
11 (68140-48-7)



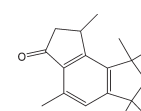
12 (88-29-9)



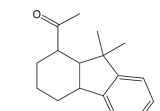
13 (92836-10-7)



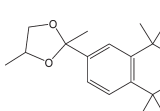
14 (1922-67-4)



15 (68298-33-9)



16 (96792-67-5)



17 (131812-67-4)

Environmental Concerns

Proof of the presence of nitromusks in the environment, more specifically in water and in fish, date back to the early eighties^{5,6}. Research on the contamination of surface water, supply and drain sites of water purification plants has intensified this decade^{7,8}. Musk xylene has been detected in human milk, fat⁹ and blood¹⁰. Polycyclic musks have been found in the environment¹¹, in human fat and milk^{12,13}.

Nitromusks as well as polycyclic musks were present at easily detectable levels in all of these studies. Their abundance in the environment, in animal or human fat and blood relates to the quantities manufactured and used world wide. I.e. $2 > 3$ and $7 > 8$. Since both polycyclic and nitromusks are highly lipophilic substances, they are easily absorbed by fat tissue where they are found in higher concentration than elsewhere. Eel, known for its high fat content, has shown 5 - 10 fold the amounts per kg than brass⁶.

The most widely used polycyclic and nitromusks have been tested intensively in the past. Toxicological and dermatological data show no harmful effect on humans, animals or the environment. However, high levels of use, extreme chemical stability and very low biodegradability¹⁴ make polycyclic and nitromusks potential environment contaminants due to their bioaccumulation.

Whereas chemical stability, i.e. resistance to chemical or biological degradation, was a highly desired property in the past, in modern ecological perfumery a fragrance has to be stable enough not to change during a product's life time, but biodegradable enough to disappear swiftly once the product has been used. Lately, more and more companies using fragrances wish to receive oils containing neither nitromusks nor polycyclic musks. This development seems to be consequent and ecologically far-sighted.

A third subgroup of musks offer themselves as replacers:

Macrocyclic Musks

This subgroup consists of partially artificial and partially nature-identical members. With the structural elucidation of Muscone (18), the macrocyclic component of the secretion of the musk deer in 1926 L. Ruzicka started the epoch of macrocyclic chemistry¹⁵.

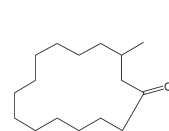
Macrocyclic musks are not only found in animals but also in plants. Compound 19 (trade names CyclopentadecanolidTM, ExaltolidTM, PentalidTM, ThibetolidTM, etc.) may serve as an important example as it is found in angelica root oil. Together with Ethylene Brassylate (20) with its trade names AstratoneTM, Musk TTM, etc. it is the most often used macrocyclic musk. Ambrettolide (21) and Civetone (22) are used rather rarely. Compounds 23-29 are some more members of this group.

The chemical structure of macrocyclic musks suggests an easy microbial decomposition which has been confirmed in single cases¹⁶.

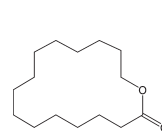
Replacements of Nitro- and Polycyclic Musks

Several problems arise when replacing nitromusks or polycyclic with macrocyclic musks. First, the odor profiles (intensity, tonality, odor threshold, tenacity, etc.) are different. As a matter of fact, some nitromusks, e.g. musk ketone with its powdery sweet strong musky odor, are very difficult to replace, even by a mixture of compounds¹⁷. Secondly, some of the macrocyclic replacers do not show the same stability behavior in certain media (e.g. strong alkaline or acidic). Thirdly, some of them are simply too expensive to be used in low-cost functional products.

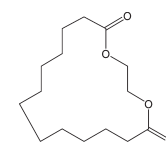
No matter how, perfumers will have to overcome these drawbacks with new inspirations. Upon increasing demand the desirable macrocyclic musks may become cheaper. Or - as a more distant possibility - new groups of musks will be found and launched in the future.



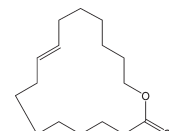
18 (541-91-3)



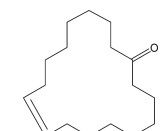
19 (106-02-5)



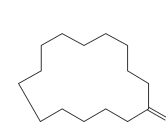
20 (105-95-3)



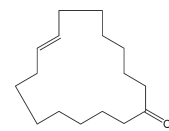
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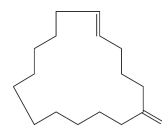
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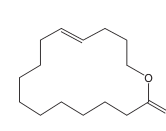
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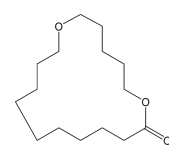
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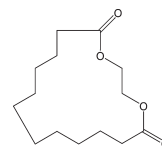
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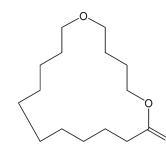
26 (34902-57-3)



27 (3391-83-1)



28 (54982-83-1)



29 (6707-60-4)

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- 11 H.-D. Eschke et al.: "Untersuchungen zum Vorkommen polycyclischer Moschus-Duftstoffe in verschiedenen Umweltkompartimenten" Z. Umweltchem. Oekotox. 6(4) 183 - 189 (1994)
- 12 G.G. Rimkus et al.: "Polycyclic Musk Fragrances in Human Adipose Tissue and Human Milk", Chemosphere 33 (10), 2033-2043 (1996)
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- 14 Amazingly few studies on biodegradability and /or metabolism of these products are available. See, e.g. [10].
- 15 L. Ruzicka, "Zur Kenntnis des Kohlenstoffringes VII. Über die Konstitution des Zibetons", Helv. Chim. Acta, 9, 230, (1926)
- 16 Internal studies by some suppliers.
- 17 This is why many products still rely on fragrances containing polycyclic and/or nitromusks, even newly introduced ones.

Review Article:

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