MUSK DEER (*Moschus moschiferus*): 
Reinvestigation of Main Lipid 
Components from Preputial 
Gland Secretion

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Abstract—The qualitative and quantitative composition of the principal lipid constituents of Siberian musk deer (*Moschus moschiferus*) preputial gland secretion, main odor carriers and potential precursors of odorous substances, was investigated by means of high-performance liquid chromatography. Free fatty acids and phenols (10%), waxes (38%), and steroids (38%) were found to be the main groups of the secretion lipids. Cholestanol (I), cholesterol (II), androsterone (III), $\Delta^4$-3a-hydroxy-17-ketoandrostene (IV), 5$\beta$, 3a-hydroxy-17-ketoandrostane (V), 5$\alpha$, 3$\beta$, 17$\alpha$-dihydroxyandrostane (VI), 5$\beta$, 3$\alpha$, 17$\beta$-dihydroxyandrostane (VII), and 5$\beta$, 3$\alpha$, 17$\alpha$-dihydroxyandrostane (VIII) were isolated from the steroid fraction and their structures confirmed by IR, PMR, and mass spectra. 3-Methylpentadecanone (muscone) was not identified among the secretion lipids. Preputial gland secretion stimulated sex behavior of musk deer females.


INTRODUCTION

The musk deer (*Moschus moschiferus*) has a preputial gland, which is found only in sexually mature males. Its secretion has a specific musk odor, and therefore the secretion's chemical constituents can be involved in chemical communication, encoding at least the information about sex and maturity. Earlier,
muscone (macrocyclic ketone, the principal odoriferous component of musk deer) (Ruzicka, 1926), a host of macrocyclic molecules (Mookherjee and Ledig, 1970), waxes and steroids (Do et al., 1975), muscopyridine (Schinz et al., 1946), and hydroxymuscopyridines (Yu and Das, 1983) were identified as components of preputial gland secretion. Muscone is claimed to be the sexual attractant for musk deer females (Mookherjee and Wilson, 1982).

The solving of chemical ecology problems for every species requires knowledge of the qualitative and quantitative composition of the compounds excreted by an animal, and their informative significance. The musk pouch composition of Siberia-dwelling musk deer has not been so far investigated by means of standard analytical techniques, and whether it is similar to that of other populations or species, and if so, to what extent, is not yet clear. Such knowledge would contribute to elucidation of the taxonomic status of the species under study and of related species. Furthermore, the standardized and quantitative analysis of skin gland secretions will be of importance in estimating the effect of chemical substances on animal interrelations.

To investigate the qualitative and quantitative composition of the main lipids (present at concentrations more than 0.5%) from preputial gland secretion, we employed high-performance liquid chromatography (HPLC), the structure of compounds isolated being confirmed by their infrared (IR), proton magnetic resonance (PMR), and mass spectral data and by comparison of the physicochemical properties with the authentic samples.

**METHODS AND MATERIALS**

**Biological Material.** The samples of the musk pouches were obtained from the animals from the area southeast of the Baykal Lake, in Siberia. This population geographically and taxonomically should be defined as *Moschus moschiferus*. The specimens from 18 individuals were obtained in the period from October to February (1979–1980), which coincided with the rutting season. The musk pouches were removed from killed animals and then air-dried by a standard method, i.e., it was exposed to open air temperatures, not exceeding 40°C, during one week. The largest pouches were obtained from adult musk deer (older than 2 years), whose preputial glands are developed to a much greater extent than those of younger sexually mature animals.

**Behavioral Observations.** The behavioral observations were carried out with 10 breeding musk deer females, kept in open air cages, Moscow Region, between 1976 and 1984. Five individuals were captured in Siberia, and five were born in captivity.

**Chemicals.** Solvents used in extraction and HPLC were of reaction grade and distilled before use. The samples of free fatty acids, their methyl esters and \( p \)-, \( m \)- and \( o \)-cresols were obtained from Chem. Service (West Chester, Pennsylvania). The samples of I–III, V, VII, and \( \Delta^4 \)-3, 17-diketoandrostene were