quantities of volatile substances. These distillates were extracted with ether, concentrated and distilled.

(6) The volatile substances were separated into four major fractions: (*a*) acids, (*b*) phenols, (*c*) bases, and (*d*) neutral substances.

(7) The four fractions distil over a wide range of temperatures, hence, they are, respectively, mixtures of many substances.

(8) The principal volatile acid was found to be benzoic acid (formed by hydrolysis of hippuric acid); hydrogen sulfide, the fatty acids up to heptylic acid, and possibly hexahydrabenzoic acid.

(9) The principal phenols are phenol and *p*-cresol; other higher phenols occur in notable quantities.

(10) Methylamine and indol occur as a trace in fresh urines and in larger quantities in fermented urines.

(11) The neutral substances of urine are the most important contributors to the odor of urine. Urinod and at least three other new substances were indicated.

SEATTLE, WASH.

[CONTRIBUTIONS FROM THE CHEMICAL LABORATORY OF THE UNIVERSITY OF WASHINGTON.]

URINOD, THE CAUSE OF THE CHARACTERISTIC ODOR OF URINE.

BY WILLIAM M. DEHN AND FRANK A. HARTMAN.

Received July 18, 1914.

Though many references are made in the literature and text-books[1] to the characteristic odor of normal urine, the direct association of this odor with chemical compounds is loosely made only to ammonia and to several volatile acids.[2] The odor of fresh urine is described as not unpleasant, while the offensive odor of fermented urine is described as ammoniacal. Apparently, the substance that imparts to all urines the characteristic odor has been overlooked by previous investigators. This substance we have isolated and analyzed; its formula is C_6H_8O and we have given to it the name *urinod*.[3]

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[1] Black, "The Urine in Health and Disease," 1896, p. 25: "In the normal condition fresh urine has a peculiar aromatic odor. The smell of urine is said to be due to the presence of phenylic, taurylic and demoluric acids....when it has undergone decomposition in the bladder it exhales an ammoniacal odor and sometimes gives off sulfuretted hydrogen;" Menninger, "Diagnosis of the Urine," 1900, p. 17: "The odor is sharp and slightly aromatic, and its cause is at present unknown;" Long, "Urine Analysis," 1900, p. 13: "The odor of urine is not easily described, as in health it is *sui generis* and characteristic;" Holland, "The Urine," 1904, p. 18: "Putrid urine has the odor of ammonia modified;" Tyson, "Practical Examination of Urine," 1903, p. 33: "The characteristic odor of urine....is putrescent and ammoniacal, the former (resulting) from decomposition of mucus."

[2] Salkowski, *Z. physiol. Chem.*, 13, 264 (1889).

[3] Latin, *urina*, urine; *odor*, smell.

If a quantity of urine is treated with sulfuric acid in the proportions of 100 to 3 and the mixture is permitted to stand for some days and is then distilled, oily films may be seen on the surfaces of the distillates and, after using the same receivers for many distillates, the inner surfaces may be seen to be coated more or less with oil. This oil is largely urinod. In this form, its odor, though very disagreeable and characteristic of urinod, is mixed with other odor-imparting substances. To obtain it pure in quantities sufficient for analysis, many liters are necessary; 1000 liters were distilled and 700 liters of distillate were taken—this ultimately yielded 5.18 g. of nearly pure urinod. Of course, some was lost during the handling, acidulation, distillation, ether extraction, concentration, treatment with acids and alkalies, distillation with steam, re-extraction, drying, and distillation *in vacuo*. From data at hand, it is estimated that *urinod occurs to the extent of only 1–2 parts in 100,000 parts of urine.* For the reason that its occurrence in urine is so small, its presence has not previously been recognized. At least, no method for its separation has previously been worked out. Even now, after three years of systematic search and laborious experiments, its separation is effected only with great difficulties.

Preparation of Urinod.

As was described in detail in the previous paper, the separation of the neutral volatile substances containing urinod consisted of the following outlined operations: The urine was treated with dilute sulfuric acid so as to make about 3% concentration of acid. The mixture was permitted to stand a number of days. The urine, now darkly colored and giving off unpleasant odors, was distilled and the distillates were extracted with ether. After washing with aqueous solutions of sodium carbonate, sodium hydroxide and hydrochloric acid to remove acids, phenols and bases, the ether solution, containing neutral substances, was concentrated to a small volume and then was subjected to steam distillation. The distillate was extracted with ether and the ether solution was shaken with metallic mercury, to remove sulfur, etc. The ether solution, always yellow or brown at this stage, was dried and further concentrated and fractionated *in vacuo*.

From 1000 liters of urine the following pure[1] fractions were obtained:

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[1] In an earlier experiment, not making use of all the refinements of the above method, 125 liters of urine were distilled and fractions were taken as follows: (A) the first 50 liters, (B) the second 50 liters, and (C) the remaining distillate. The ether extracts from these distillates were concentrated and treated with anhydrous potassium carbonate, which of course removed acids but not phenols. To (C) was added the tarry residues from the distillations (A) and (B); the ether solution of (C) was then treated with sodium carbonate to remove acids, and with potassium hydroxide to re-

From the first 700 liters of distillate.	Grams.	*t.*	*p.*
(1)........	1.31	108°	30–29 mm.
(2)........	2.21	108–113°	29 mm.
(3)........	1.66	113–128°	29 mm.
Total....	5.18		

From the remainder of the distillate.	Grams.	*t.*	*p.*
(1).........	1.1867	100°	31 mm.
(2).........	0.5181	100–120°	31 mm.
(3).........	0.9575	120–140°	30 mm.
(4).........	0.2767	140–160°	29 mm.
(5).........	1.0216	160–175°	29 mm.
Total.........	3.9606		

Fraction 2 was used most largely for analysis, though Fraction 3 gave quite concordant data.

Calculated for C_6H_8O: C, 75.01; H, 8.33; O, 16.66

Found: C, 75.08; H, 8.19; O, 16.73

Found: C, 75.01; H, 8.08; O, 16.91

Found: C, 74.95; H, 8.26; O, 16.79

Average, C, 75.01; H, 8.18; O, 16.81

Calculated molecular weight: 96.06

(With McCoy's apparatus, boiling point method):

Found (with ether as the solvent): 94.90 95.20

Found (with benzene as the solvent): 97.90

Since the most refined methods failed to show the presence of other elements, the empirical formula is established as C_6H_8O.

The boiling point of urinod is 108° at 28 mm. Its boiling point is estimated to be about 208° at ordinary pressure; however, it cannot be dis-

move phenols. After drying with calcium chloride, the ether solution was concentrated and distilled *in vacuo.*

Distillate.	Fraction.	Weight.	Temperature.	Pressure.	Color.
A.....................	1	0.1767	105–108°	32–26	Brown to red
	2	0.6097	110–110.5°	25–24	Yellow
B.....................	1	0.1208	111°	28	
	2	0.4594	102–108°	28	
C.....................	1	?	106–118°	32–31	
	2	?	124–130°	30	
	3	0.2489	148–174°	30	
	4	0.6205	179–210°	30	
Total........................		2.2356			

Here phenols, sulfur and probably paraffin contaminated the urinod. Analyses of these impure fractions, especially of A–2, showed approach to the percentages of composition of urinod:

Calculated for C_6H_8O: C, 75.01; H, 8.33; O, 16.66.

Found: C, 69.25, 72.40, 71.30, 69.19, 71.81, 69.13.

Found: H, 8.33, 8.06, 8.01, 8.01, 8.07, 8.27.

Found: N, 7.15, 13.06, 18.00.

Found: S, 1.61 (333° in Carius tube)

The nitrogen indicated was found to be largely carbon monoxide—urinod decomposing with almost explosive violence. The trace of sulfur was probably owing to free sulfur. Some of these fractions yielded free iodine when treated with nitric acid; this was probably distilled from iodides contained in the urine.

tilled at ordinary pressure without decomposition. Urinod does not solidify in an ordinary freezing mixture. It is a light yellow oil, slightly heavier than water. It is soluble in ordinary organic solvents, but is insoluble in water. It is very volatile with steam. It has a very penetrating, persistent, nauseating odor of urine. A drop of urinod placed upon filter paper retained its odor after fifteen months. It is very toxic, as will be shown in a following paper.

Urinod darkens rapidly in direct sunlight, reduces potassium permanganate and ammoniacal silver nitrate in the cold, reacts with Millon's reagent, but not with Fehling's reagent or an alkaline solution of picric acid. With fixed alkalies the odor of urinod is changed to a terpene-like odor.

Derivatives of Urinod.

Nitro Derivatives.—Urinod reacts with concentrated nitric acid with explosive violence; with dilute nitric acid its disagreeable odor is quickly destroyed. Apparatus containing traces of urinod may be freed from the same by mere washing with nitric acid.

For the preparation of nitro derivatives, cold, dilute nitric acid is added to the urinod and the mixture is permitted to stand for a day. Needles or brown sticky masses are obtained. After drying on a clay plate and recrystallization from hot water, golden needles melting at 78° were obtained.

Calc. for $C_6H_6N_2O_5$: C, 38.71; H, 3.22; found: C, 39.01; H, 3.90.

The *dinitro urinod* is easily soluble in ether, benzene and chloroform, less soluble in water and carbon disulfide. When first formed it was probably mixed with an oily *mononitro urinod.*

With Semicarbazide.—A mixture of equimolecular quantities of urinod, semicarbazide hydrochloride, and sodium acetate in a water-alcohol solution was heated for several hours under a return condenser. Gradually, a granular precipitate formed. From 1.1 g. of urinod (Fractions 1–3), 0.4 g. of the precipitate was obtained. The crystals were insoluble in all organic solvents, practically insoluble in water, but soluble in alkali, from which hydrochloric acid slowly precipitated thin, hexagonal leaflets melting at 254°. The hot alkali solution gave off ammonia, indicating decomposition.

	Calculated for		Found.		
	$C_4H_{11}O_3N_6$.	$C_4H_{13}O_3N_6$.	I.	II.	III.
C	25.11	24.84	24.67	24.50	24.07
H	5.79	6.77	5.97	5.64	6.43
O	25.12	24.87	...	...	...
N	43.98	43.52	45.69	46.10	...

Too little evidence is at hand to judge of the nature of this compound except that: (1) it represents a split portion of urinod;[1] (2) it is a *complex acidic compound.*

With Hydroxylamine.—When an equimolecular mixture of urinod, hydroxylamine hydrochloride, and sodium acetate in alcohol-water solution, was permitted to stand, or was heated to 100° in a sealed tube, only an oil of a modified not unpleasant odor, which did not solidify in a freezing mixture, was obtained.

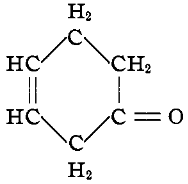
With Bromine.—When urinod was treated either with bromine water or with bromine contained in carbon tetrachloride, hydrobromic acid and a dark-colored sticky mass were obtained. This mass was nearly odorless and consisted of at least two compounds: (1) a solid soluble in chloroform and ether but insoluble in absolute alcohol and melting at about 110°; (2) a solid soluble in chloroform, insoluble in ether and not melting at 250°. Owing to the small quantities on hand these bromo-derivatives were not studied further.

The remarkable chemical properties of urinod are shown not only in the vigor of reaction with various reagents but also in their almost universal formation of secondary reaction products. For instance, with bromine, two or more substances are obtained; with hydroxylamine, no crystallizable oxime;[2] with phenylhydrazine, no crystallizable hydrazone; with semicarbazide, an anomalous compound; with nitric acid, an oil and a small yield of the dinitro derivative; all these chemical properties argue for an exceptional formula for urinod.

The Constitution of Urinod.

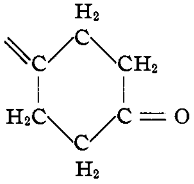
The formulas[3] agreeing with the properties of urinod thus far studied are as follows:

(a)



(3-Cyclohexane ion)

(b)



("Tetrahydro-semiquinone")

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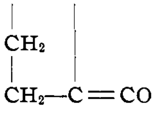
[1] Since Fraction 4 of the urinod distillates did not yield this compound, but all the lower fractions did, it is evident that the crystalline compound is a product of urinod.

[2] For peculiar reaction of 2-cyclohexene-1-on with hydroxylamine, see Kötz and Grethe, *J. prakt. Chem.*, 80, 473. They obtained an oxime melting at 75–76° and 3-hydrooxyaminocyclohexanonoxime melting at 49–51°. For oxidizing influences of hydroxylamine, see *J. prakt. Chem.*, [2] 29, 497; *Ber.*, 19, 305; 20, 614; 29, 2080.

[3] Pentamethylene keten is also a possible formula,



(1) Urinod is insoluble in hot dilute solutions of hydrochloric and sulfuric acids, hence it cannot contain a basic (or alcohol-oxygen or ether-oxygen) group.

(2) Urinod is insoluble in dilute solutions of alkalies, hence it cannot contain an acidic or phenolic group.

(3) Urinod is optically inactive, hence, if not a racemic mixture, it cannot contain an asymmetrical carbon atom.

(4) Urinod reacts with bromine contained in carbon tetrabromide, giving a strong evolution of hydrogen bromide and a solid bromo-derivative; hence it is a *cyclic* compound.

(5) Urinod reacts with cold, dilute nitric acid, giving golden needles of *dinitro-urinod*, melting at 78° and possessing the formula $C_6H_6N_2O_5$, hence it is a *cyclic* compound.

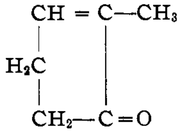
(6) Urinod reacts with *semicarbazide*. Forming a compound melting at 254°, hence it is a *ketone* or an *aldehyde*.

(7) Urinod reacts with hydroxylamine, phenylhydrazine and hydrogen sulfide, forming derivatives not possessing the characteristic odor of urinod. These compounds, though not purified and analyzed, indicate the presence of the *carbonyl* group in urinod.

(8) Urinod is easily oxidized by ammoniacal silver nitrate, also by aqueous solutions of potassium permanganate, thus indicating close relation with hydrobenzene derivatives.

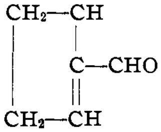
Known compounds possessing the same empirical formula as urinod but not agreeing with it in properties are the ethyl and dimethyl furanes,[1] acetyldimethylacetylene[2] and the following:

(*c*)



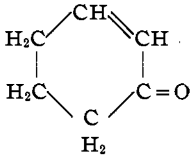
(2-Methyl-2-cyclopentene-1-on)[3]

(*d*)



(1-Cyclopentene-1-aldehyde)[4]

(*e*)



(2-Cyclohexene-1-on)

2-Cyclohexene-1-on,[5] with which urinod is assumed to be isomeric, also the homologs of the former, differ widely from urinod in properties:

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[1] Priebs, *Ber.*, **18**, 1362; Dietrich and Paal, *Ber.*, **20**, 1085; Fisher and Laycock, *Ber.*, **22**, 103; Laycock, *Chem. News*, **78**, 224; Nasini and Carrara, *Gazz. chim. ital.*, **24**, 278.

[2] Griner, *Ann. chim. phys.*, [6] **26**, 369. This compound boils at 149–150° and possesses the formula $CH_3COCH_2.C:C.CH_3$.

[3] Looft, *Ann.*, **275**, 372; *Ber.*, **27**, 1538; Bouveault, *Compt. rend.*, **125**, 1184. This compound boils at 157° and possesses a sharp aromatic odor.

[4] Kekulé, *Ann.*, **162**, 105; Baeyer and H. v. Leibig, *Ber.*, **31**, 2107. This compound boils at 172°, possesses the odor of benzaldehyde and is quite soluble in water. Its semicarbazone melts at 208°.

[5] Kötz and Götz, *Ann.*, **358**, 183; Kötz and Grethe, *J. prakt. Chem.*, 80, 473; Kötz, Blendermann, Mähnert and Rosenbusch, 400, 72; Tshugaer, *J. prakt. Chem.*, 81, 188.

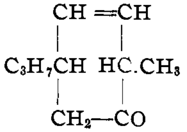
	B. ps.	M. p. semicarbazone.
(*a*) 3-Cyclohexene-1-on (urinod)	108° at 29 mm.	254°
(*e*) 2-Cyclohexene-1-on	63° at 14 mm.	161°
3-Methyl-2-cyclohexene-1-on	81–85° at 13 mm.	..
3,6-Dimethyl-2-cyclohexene-1-on	75° at 19 mm.	..
2,3-Dimethyl-2-cyclohexene-1-on	119° at 12 mm.	225°

The 2-cyclohexene-1-on possesses many properties of a phenol, indeed it is supposed to possess the tautomeric from of 1,5-dihydrophenol;[1] this, like phenol, tetrahydrophenol,[2] and hexahydrophenol,[3] but unlike urinod, is soluble in water as well as in alkalies. Thus, since all these compounds, as well as the dihydrophenols, are eliminated from the discussion of the constitution of urinod, only formulas (*a*) and (*b*) remain.

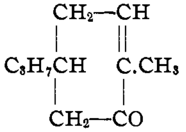
From considerations of the cresols, the diphenols, the monohalogen phenols, the monohydroxy anisols and phenetols, etc., it is observed that the boiling points of the meta and para compounds are some 10–40° higher than the corresponding ortho compounds. By analogy, it may be assumed that a compound with the formula (*a*), with its double bond more distant from the oxygen atom than a compound possessing the formula (*e*), would have a higher boiling point. This may be especially true of a compound of the formula (*b*), and thus the high boiling point of urinod may be accounted for.

Some of the terpene ketones may be considered to be homologues of urinod. For instance, (*f*) dihydrocarvone[4] is 2-methyl-5-isopropyl-urinod, while (*g*) terpenone,[5] (*h*) carvenone[6] and (*i*) 3-terpene-5-on[7] are methyl-isopropyl homologues of Kötz's 2-cyclohexene-1-on.

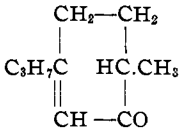
(*f*)



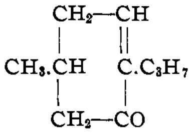
(*g*)



(*h*)



(*i*)



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[1] Kötz, etc., *Ann.*, 400, 72. The 3,6-dimethyl-2-cyclohexene-1-on is described as possessing a pleasant menthone-like odor.

[2] Baeyer, *Ann.*, **278**, 97. This compound boils at 166° and is quite soluble in water.

[3] Baeyer, *Ann.*, **278**, 97; Markownikow, *Ibid.*, **302**, 20. This compound boils at 161° and is soluble in 28 volumes of water.

[4] Wallach, *Ann.*, **275**, 115; **279**, 378; **300**, 290; **313**, 368; **314**, 164; Brühl, *Ber.*, **32**, 1225.

[5] Baeyer, *Ber.*, **29**, 35.

[6] Wallach, *Ann.*, **277**, 122; **286**, 130; **287**, 381; **305**, 270; Baeyer, *Ber.*, **27**, 1921; **28**, 1592; Tiemann and Semmler, *Ber.*, 31, 2889.

[7] Wallach, *Ann.*, **305**, 272; Baeyer, *Ber.*, **28**, 1587; Kremers, *Am. Chem. J.*, 16, 395; 18, 762.

A comparison of boiling points:

(*a*) 3-Cyclohexene-1-on (urinod)	108° at 28 mm.	.....
(*b*) 2-Cyclohexene-1-on	63° at 14 mm.	.....
(*f*) Dihydrocarvone	104° at 18 mm.	222° at 760 mm.
(*g*) Terpenone	......	235° at 760 mm.
(*h*) Carvenone	112° at 14 mm.	236° at 747 mm.
(*i*) 3-Terpene-5-on	97° at 12 mm.	208° at 760 mm.

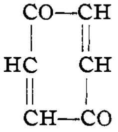
shows that some of the homologs of (*e*) are higher boiling than dihydrocarvone, the homologue of urinod. Of course, the establishment of the constitution of some of these formulas is doubtful, so that conclusions drawn therefrom as to the relative boiling points of (*a*) and (*e*) cannot be final.

That urinod may possess the exceptional formulas (*b*) gathers support from consideration of its characteristic toxic properties and its odor—the isocyanides and other bivalent[1] carbon compounds being both toxic and malodorous.

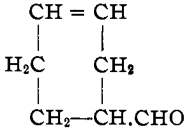
It is of special interest to study the properties of urinod in connection with other closely related compounds, such as quinone and tetrahydrobenzaldehyde.

(1) Urinod, quinone, dihydrocarvone, and 3-tetrahydrobenzaldehyde[2] all possess similar solubilities, strong odors and closely related structural formulas; compare (*a*) and (*f*) with the following:

(*j*)



(*k*)



(2) Urinod and quinone are both yellow in color and darken on standing in sunlight.

(3) Both urinod and 3-tetrahydro-benzaldehyde polymerize readily.

(4) Urinod, dihydocarvone and tetrahydro-benzaldehyde are extremely easily oxidized—a general property of reduced benzene compounds.

Urinod Occurs in the Conjugated Form.

That urinod does not occur free in fresh, normal urine is concluded from consideration of the following evidence:

(1) The odor of freshly voided urine is not pleasant, *i. e.*, in such urine the odor of urinod itself is absent, or is present only as a trace, that is its conjugated form is not unpleasantly evident to the sense of smell.

(2) Fermentation, or treatment with hydrolyzing agents, develops

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[1] See the views of Nef, *Ann.*, 280, 303; 287, 274; 298, 202; also see Wade, *J. Chem. Soc.*, 81, 1596; Lawrie, *Am. Chem. J.*, 36, 487.

[2] Sobecki, *Ber.*, 43, 1040. The odor is described as extremely unpleasant, suggestive of benzaldehyde and isovaleric aldehyde. Compare with hexahydrobenzaldehyde, Frezouls, *Compt. rend.*, 154, 707.

very unpleasant odors, which, though composite, as will be shown, are easily recognized as containing urinod.

(3) Urinod itself is very toxic, as will be shown, hence for physiological reasons, it must be transformed to the innocuous, conjugated form to be eliminated.

(4) Urinod is easily volatile with steam, but each fraction of distillate from urine and even the heated residue gives off the odor of urinod, hence not only is its formation by hydrolysis difficult, but, *a priori*, it must exist in the conjugated form.

(5) This conclusion gains further support from consideration of many of the other substances in urine, which are shown to be in the conjugated form. For instance, ammonia is conjugated in urea; urea, in uric acid and other purine bases; benzoic and phenylacetic acid, in hippuric and phenylaceturic acids; phenol, *p*-cresol, other phenols, indol, skatol, etc., in sulfonates and glycuronates.[1]

The Odor of Urine.

The odor of urine, though largely caused by urinod, is blended with basic, acidic, phenolic and other neutral compounds, under different conditions of alkalinity, acidity and neutrality. Since urinod is not found in fresh urine in the free state, its offensive odor is not developed unless urine is permitted to ferment, is evaporated or ignited, is treated with acids or alkalies, or is secreted under pathological conditions.

The odors of fresh urines, evaporating urines, fermenting urines, distillates from alkali-treated urines, distillates from acid-treated urines and even different fractions of the latter two, all possess the characteristic odor of urinod but are quite readily distinguished by the sense of smell, for the reason that secondary odoriferous substances also are present.

Fresh urine possesses only a slight odor, which probably is caused by the conjugated form of urinod or by its partial splitting into urinod.

Urines, while being evaporated and ignited, probably possess the odors of urinod, conjugated urinod, indol, the lower fatty acids, phenols and other undetermined substances.

Fermenting urines probably possess the odors of urinod, ammonia, ammonium sulfide, indol and phenols.

Urines treated with alkalies probably possess the odors of ammonia, alkylamines, indol, phenols and urinod.

Urines treated with acids, as was shown in the previous paper, possess the odors of a great variety of volatile substances, but especially the odors of urinod, the lower fatty acids and the simple phenols.

Since urea and other urinary compounds occur in small quantities in

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[1] For comprehensive experiments on alicyclic compounds in combination with glycuronic acid in urine, see Hämäläinen, *Skand. arch. Physiol.*, **27**, 141; see also Levy, *Biochem. Z.*, **2**, 314 on the conjugation of glycuronic acid with optical antipodes.

perspiration, and since in cases of obstructed excretion of urine they occur in larger quantities in perspiration, it may be concluded that the conjugated form of urinod or urinod itself may also be excreted by the skin. That such is the case is quite evident to one familiar with the odor of pure urinod. Indeed this body odor may also be a large factor in the composite odor of ill-ventilated, occupied rooms.

The Use of Antiseptics in Urinals.

The various preparations for urinals can have only three uses:

(1) Destructive effects upon bacteria.
(2) Destructive effects upon uriniferous odors.
(3) Solvent effects upon earthy phosphates, etc.

As was shown in a previous paper,[1] most preservatives for urine have only partial inhibitory power, unless applied in quite concentrated solutions. It is doubtful whether the quality or the quantity of the antiseptics ordinarily applied in urinals have any meritorious bactericidal effects.

The most important odor-imparting substances of urine are ammonia, phenols, aliphatic acids, indol and urinod. Since all these substances, except urinod and indol, are soluble in water, intermittent flushing of urinals with water will remove all but traces of urinod and indol.

Since urinod, the most ill-smelling substance of urine, is easily acted upon by free halogen to form inodorous derivatives, the use of bleaching powder in urinals has scientific basis. The use of naphthalene, other hydrocarbons, and phenols, with which urinod is not chemically reactive, can have no justification beyond their feeble antiseptic effects. These and many other commercial preparations may mask but not destroy the odor of urinod.

Oxidizing reagents, such as bleaching powder, the halogens, nitric acid, the oxides of nitrogen, permanganate solutions, etc., speedily destroy urinod. Of course, bleaching powder, the halogens and the higher oxides of nitrogen themselves possess disagreeable odors and, therefore, are objectionable reagents for urinals.

Because of its insolubility in water and ordinary cleansing materials, urinod is removed with difficulty from the hands of the worker in the laboratory. This property of urinod accounts for the failure to remove odor of urine from lavatories by ordinary methods of cleansing.

Strunk[2] made extensive investigations of oils for urinals and concluded that they consist chiefly of creosote oils and petroleum. Such oils, having weak disinfecting power, act chiefly as deodorizers and cleansing agents. They cannot, however, have chemical effects upon urinod and their solvent effects upon it hardly justifies their use.

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[1] THIS JOURNAL, 36, 409 (1914).

[2] Veröff, *Geb. Militär-sanitätswes.*, 45; *Arch. hyg., Chem. Untersuchungsstellen*, IV, 31 (1911); *Apoth. Ztg.*, 26, 146, 156, 167; *C. A.*, 5, 2681.

It is concluded from our studies that frequent use of water for flushing purposes in urinals and the occasional application of dilute nitric acid as a washing material is effective not only for destroying the urinod but also for dissolving earthy phosphates and other precipitated materials.

The Physiological Significance of Urinod.

For the reason that urinod is found at day or night in all normal or pathological urines, like urea, uric acid, creatinine, etc., it must bear some constant relation to metabolism. From evidence at hand, the relation of urinod to the body functions remains purely speculative or unknown.

It is our purpose to make a systematic search for the tissues originating urinod and to determine whether it is an absorption product of intestinal putrefaction or it is a waste product of metabolism. These and further studies of the chemical properties of urinod are reserved.

Summary.

(1) A neutral ill-smelling substance, with empirical formula, C_6H_8O, has been separated from urine. Its structural formula probably is 3-cyclohexene-1-on. It occurs in urine in the conjugated form and is set free by fermentation and the decomposing effect of dilute sulfuric acid.

(2) It is a most characteristically smelling compound and seems to be excreted in all samples of urine.

(3) Its relation to metabolism, though apparently constant, is at present unknown.

(4) It is very toxic and may bear some relation to uremia.

SEATTLE, WASH.

SOME OBSERVATIONS ON THE EXCRETION OF CREATININE BY WOMEN.

BY MARY HULL.

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The following observations are submitted as a contribution to the question of the extent of creatinine elimination under varying conditions. The relations in general have been studied by several writers, especially by Folin[1] and by van Hoogenhuyze and Verploegh,[2] while the points to be covered here are concerned with only one phase of the subject, *viz.*, the extent of creatinine excretion in a group of women in normal health with a normal diet. The long papers of van Hoogenhuyze and Verploegh contain a mass of data throwing light on the relation of the excretion to certain diets, and also the course of the excretion in pathological conditions, especially in high fevers. But the subjects of the observations were men, in the normal cases, at least, and the question of the relations

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[1] Folin, Hammersten's *Festschrift* and other contributions, largely *Journal of Biological Chemistry*.

[2] van Hoogenhuyze and Verploegh, *Z. Physiol. Chem.*, **46**, 415 (1905); **57**, 161 (1908).