by other methods. Thus glycocoll, or amido-acetic acid, may be derived from monochloracetic acid: $CH_2Cl.COOH + NH_3 = CH_2(NH_2).COOH + HCl$, or from cyanoformic acid: $CN.COOH + 2H_2 = CH_2(NH_2).COOH$. They appear to be practically non-poisonous.

Delta-amido-n-valerianic acid, $CH_2(NH_2).(CH_2)_3.COOH$, one of the butalanins (Salkowski's base), is the lowest term of the series which is known to be a putrid product, and is formed by decomposition of fibrin and of muscular tissue. It is a solid, fusing point 156°, very soluble in water. Its hydrochlorid crystallizes in stellate bundles, and is very soluble in water and in alcohol. Its platinochlorid is soluble in hot water, difficultly soluble in cold water and in alcohol. It is not identical with the amido-valerianic acid obtained by Gorup-Besanez from ox pancreas, or produced synthetically from monochloro-valerianic acid, as it does not form precipitates with ammoniacal silver nitrate or with cupric acetate.

Inactive-a-amido-isobutyl-acetic acid, $(CH_3)_2:CH.CH_2.CH(NH_2).COOH$, *animal leucin*, is one of the twenty-nine isomeric amido-caproic acids, or leucins, whose constitution is demonstrated by its formation from isovaleric aldehyd, $(CH_3)_2:CH.CH_2.CHO$. It is produced, along with tyrosin, in the decomposition of proteins with dilute acids or alkalies, by putrefaction, and by tryptic digestion. It is found in the cultures of the bacillus of malignant œdema, and, along with tyrosin, in those of anthrax and comma bacilli, and in the products of decomposition of fibrin by streptococci. It appears to exist also as a normal constituent of the pancreas, spleen, thymus, lymphatic and salivary glands, liver, and kidneys. Pathologically the quantity of leucin is much increased in the liver in diseases of that organ, in typhus and in variola; in the bile in typhus; in the blood in leukæmia, and in yellow atrophy of the liver; in the urine in yellow atrophy of the liver, in typhus, in variola, and in phosphorus poisoning; in choleraic discharges; in pus; and in the fluids of dropsy and of atheromatous cysts. It is probable that leucin exists as a constituent factor of the proteins, and is split off during their decomposition, as is the case with the hexon bases, arginin and lysin, both of which are related to it, the former being the guanidin compound of a diamido-valerianic acid, and the latter a diamidocaproic acid.

Leucin crystallizes from alcohol in pearly plates; but is more usually met with in rounded masses of closely grouped, radiating needles. It is sparingly soluble in water, almost insoluble in alcohol and ether, but readily soluble in hot water or alcohol. It is odorless and tasteless, and its solutions are neutral. It dissolves readily in acids and in alkalies, forming crystalline compounds with the former. It fuses without decomposition, and sublimes at 170°. Hydriodic acid under the influence of pressure and heat decomposes it into caproic acid and ammonia. Its hot solutions form precipitates with hot solutions of cupric acetate; and they dissolve cupric hydroxid, but do not reduce it on boiling. When heated with mercurous nitrate solution it liberates metallic mercury.

Amidostearic acid, $C_{18}H_{35}(NH_2)O_2$, has been found by Schutzenberger among the products of putrefaction of muscular tissue. The amido acids, $C_{11}H_{26}N_2O_6$ and $C_8H_{20}N_2O_3$, obtained by the same experimenter, are probably mixtures. The former, on decomposition by caustic potash, yields, besides ammonia, potassium carbonate, valerate and butyrate, while the latter under like treatment yields caproate, caprylate, and acetate.

Schutzenberger has also described a class of substances to which he has given the name "leuceins," differing from the leucins by containing two hydrogen atoms less, possibly amidoacrylic acids. Of these he found butyric leucein, $C_4H_5(NH_2)O_2$, and valeric leucein, $C_5H_7(NH_2)O_2$ among the products of putrefaction of muscular tissue.

Aspartic acid, or amidosuccinic acid, $COOH.CH(NH_2).CH_2.COOH$, and glutamic acid, or amidoglutaric acid, $COOH.CH(NH_2).CH_2.CH_2.COOH$, although known as products of decomposition of proteins by the action of acids and in tryptic digestion, have not been found to be products of putrefaction. Schutzenberger obtained an amido acid having the formula $C_9H_{15}NO_4$, which yielded an isomere of allylamin, $C_7H_{15}N$, on decomposition, from putrefying muscular tissue, and Guareschi obtained a base, $C_{14}H_{20}N_2O_4$, from putrid fibrin. These two bases appear to be amido derivatives of dicarboxylic acids, although they are not homologues of the aspartic series.

Tyrosin, or *p-oxyphenylalanin* $(HO)_{(4)}C_6H_4.CH_2.CH(NH_2).COOH$, is one of the earliest known products of decomposition of the proteins, and is formed from them by the action of proteolytic enzymes, by putrefaction, and by the action of acids or of alkalies, always accompanied by leucin. It also exists normally in the intestinal contents, and pathologically in the urine. It has been obtained synthetically from phenyl-acetaldehyde, $C_6H_5.CH_2.CHO$. It crystallizes in silky needles, arranged in stellate bundles, difficultly soluble in cold water, soluble in 150 parts of hot water, insoluble in alcohol or in ether, rather soluble in the presence of acids or of alkalies. It is not poisonous. Tyrosin is a phenolic derivative of *β-phenyl-a-amidopropionic acid*, $C_6H_5.CH_2.CH(NH_2)COOH$, or *phenylalanin*, which is also a product of putrefaction.

Alkaloids.—There are nine ptomaïns known which may, with more or less reason, be called alkaloids. Of these seven are pyridin or dihydropyridin derivatives, related to the bases which occur in bone oil. The other two are benzopyrrole derivatives.

DeConinck's base, $C_8H_{11}N$, *(a collidin?)* was obtained, along with the base $C_{10}H_{15}N$, from putrid jelly-fish after one to two weeks. It is a yellowish, mobile liquid, having an acrid odor, very sparingly soluble in water, soluble in ethylic and methylic alcohols, ether and acetone. Spec. grav. 0.9865. Boils without decomposition at 202°. Turns brown, and absorbs water rapidly from air, but dose not appear to absorb carbon dioxid. Its hydrochlorid forms a fine, yellowish, crystalline, deliquescent mass, very soluble in water. Its platinochlorid is an orange-colored powder, almost insoluble in cold water, soluble in hot water, and is moderately stable. It forms a modified platinochlorid $(C_8H_{11}N)\,PtCl_4$, with boiling water. Its aurochlorid is a yellow precipitate, permanent in the cold. It forms two crystalline mercurochlorids. Its iodomethylate crystallizes in needles, and is colored red by caustic potash. When oxidized by potassium permanganate it yields nicotinic, or β-picolinic acid, also formed by oxidation of β-picolin, which by distillation with lime yields pyridin (C_5H_5N). This base is isomeric with Nencki's base, β-phenyl-ethylamin (see above), and appears to be one of the twenty-two possible collidins, the third superior homologues of pyridin. It is not *a*-propylpyridin, or conyrin, a product of the action of zinc chlorid and heat upon coniïn, which boils at 165°–166°, but is said to be either β-propyl- or β-isopropylpyridin. If it be the former, $C_5H_4N(C_3H_7)_2$, it is that ptomaïn which most nearly approaches the constitution of the most simply constituted of the vegetable alkaloids, coniïn, which is *a*-propylpiperidin, $_2C_5H_{10}N(C_3H_7)_{(2)}$.

Gautier and Etard's base, $C_9H_{12}N$, *(a parvolin?)* was found, along with the base $C_8H_{13}N$, among the products of the prolonged putrefaction of fish and of horseflesh. It is an amber-colored liquid, having the odor of hawthorn, sparingly soluble in water, turning brown and resinous in air, and boiling above 210°, at which temperature it also decomposes into ammonia and a substance having a phenolic odor. Its platinochlorid is crystalline, flesh-colored, sparingly soluble in water, and decomposed by light. Its aurochlorid is rather soluble in water. Whether or not this base is one of the fifty-seven possible parvolins, of which five only are at present known, remains to be determined.

Guareschi and Mosso's base, $C_{10}H_{15}N$, *(a coridin?)* was obtained from fibrin after five months' putrefaction. It is a brownish oil with a faint odor of pyridin and of coniïn, sparingly soluble in water, strongly alkaline, and resinifies rapidly in air. Its hydrochlorid crystallizes in thin, colorless plates, slightly deliquescent, resembling cholesterin. Its platinochlorid is flesh-colored, crystal-

line, insoluble in water, alcohol, or ether, not decomposed at 100°, and does not resinify. The same base was also extracted from fibrin after eight to nine months' putrefaction. The quantity of hydrogen obtained in all analyses of this base caused the authors to doubt whether its formula should not be $C_{10}H_{13}N$, in place of $C_{10}H_{15}N$, which would make it an isomere of tetrahydromethyl-quinolin. On dry distillation the base yields ammonia and a liquid boiling at 200°, which had a composition neighboring to that of Gautier's hydrocollidin. Gautier and other chemists called this base corindin, or better, coridin, a name already given by Thenius to the base $C_{10}H_{15}N$ which he extracted from coal tar. It is not demonstrated that this base is identical with Thenius' base, which boils at 211°, spec. grav. 0.950; whose platinochlorid is dark orange, sparingly soluble in water, alcohol, and ether; and whose aurochlorid is dark yellow. Guareschi and Mosso's base has a poisonous action resembling that of curare, but much less intense.

De Coninck obtained from jelly-fish, after one to two weeks' putrefaction, a base having the same composition as the above, which forms yellowish needles, which becomes viscid and resinous in air, has an odor which is not disagreeable, spec. grav. 1.18, boiling at 230°, sparingly soluble in water, soluble in alcohol, ether, and acetone. Its hydrochlorid crystallizes in yellowish, very deliquescent needles. Its platinochlorid forms a reddish powder, insoluble in water, but forming a modified platinochlorid $(C_{10}H_{15}N)\,PtCl_4$, which fuses at 206°. Gautier considers this as identical with Guareschi and Mosso's base. It does not seem, however, to be identical either with that or with Thenius' base. It is probable that each of the three is one of the one hundred and five possible coridins. The formation of the modified platinochlorid is strong evidence that de Coninck's base is a pyridin homologue.

Gautier and Mourgues' base, $C_7H_{11}N$, *(a dihydrolutidin?)* constitutes about one-ninth of the bases obtained by them from brown cod-liver oil. It is a colorless liquid, oily, alkaline, not disagreeable in odor, absorbs carbon dioxid from the air, lighter than water, boiling point 199°, and sparingly soluble in water. Its hydrochlorid crystallizes in flat needles, bitter in taste. Its nitrate reduces silver nitrate. Its platinochlorid forms a silky, yellow precipitate, and yields the modified platinochlorid $(C_7H_{11}N)\,PtCl_4$, when boiled with water. Its aurochlorid crystallizes in needles or in lozenges. The base unites with methyl iodid, forming a colorless iodomethylate, $C_7H_{11}N.CH_3I$, soluble in water and in ether, and having a disagreeable, nauseous odor. Caustic potash separates from it a colorless, highly alkaline oil, which is said to be dihydromethyllutidin. When oxidized by potassium permanganate in boiling solution it gives off an agreeable odor of coumarin, and, on continuing the heating at 100° in sealed tubes, a methyl-carbopyridic acid, $C_5H_3(CH_3)N.COOH$, is obtained. That this base is a hydropyridic compound is shown by the action with silver nitrate, the formation of the modified platinochlorid, and the composition of the iodomethylate. The formation of the methylcarbopyridic acid shows that it is not one of the three ethyldihydro derivatives, but one of the six dimethyl compounds.

It is very poisonous. In small doses it diminishes the general sensibility. In larger doses it causes localized tremors, particularly in the head, deep depression, with periods of extreme excitement, paralysis, beginning with the posterior extremities, and death.

Gautier and Etard's base, $C_8H_{13}N$, *(a dihydrocollidin?)* was obtained from the products of the prolonged putrefaction of fish. It is an oily liquid, having a tenacious odor of lilac, spec. grav. 1.0296, boiling point about 210°. In air it absorbs carbon dioxid, and resinifies rapidly. It has an energetic reducing action. Its hydrochlorid crystallizes in needles, soluble in water and in alcohol. Its platinochlorid is flesh-colored, sparingly soluble, and is decomposed by light or heat. Its aurochlorid is soluble and reduces easily. It was supposed by Gautier and Etard to be identical with the dihydrocollidin obtained by Cahours and Etard by the action of selenium upon nicotin; but as that base boils at 205°, and is lighter than water, it is more probably an isomere. It is actively poisonous. Even in small doses it causes vomiting, staggering, tetanic spasms, followed by paralysis and death, with the heart in diastole.

The existence of the base $C_{10}H_{17}N$, described by Griffiths, requires confirmation. The composition is that of the dihydrocoridins.

Morrhuic acid, $C_9H_{15}NO_3$, was obtained by Gautier and Mourgues, along with the bases elsewhere referred to, from brown cod-liver oil. It is oily or resinous, but crystallizes in flat prisms, or lozenges on standing. It has an odor resembling that of seaweed. It is both acid and base, and decomposes the carbonates. It forms no precipitate with cupric acetate, even on boiling. Distilled with lime, it yields an oily, alkaline base, which forms an iodomethylate with methyl iodid. It is a pyridin derivative, and is supposed by Gautier and Mourgues to be a monocarboxylic oxyacid, $C_5H_3N(OH)(C_5H_8.COOH)$, derivable from a dihydropropylpyridin. It is said to yield a monobasic acid on oxidation, but it is such itself.

Indole, C_8H_7N, is benzopyrrole, theoretically formed by fusion of a pyrrole ring, C_4H_5N, upon a benzene ring, C_6H_6, with loss of C_2H_4, the nitrogen atom occupying a position vicinal to the benzene ring. It is one of the products of putrefaction of the proteins by anaërobic bacteria, occurs in the cultures of the comma bacillus and of that of tetanus, and is formed in the intestine. When produced by intestinal putrefaction it is partly discharged in the fæces, and is in part reabsorbed, appearing in the urine in combination with sulfuric and glucuronic acids as the so-called urinary indican. It crystallizes in large, shining, colorless plates, having the disagreeable odor of naphthylamin, sparingly soluble in water, soluble in alcohol and in ether, fuses at 52° and distils with vapor of water. It is weak base, and its salts are decomposed by boiling water. Its aqueous solution, acidulated with hydrochloric acid, is colored rose-red by potassium nitrite. By fusion with caustic potash it yields anilin. Its alcoholic solution, acidulated with hydrochloric acid, colors a pine shaving red. With picric acid it forms a compound crystallizing in red needles. With sodium nitroprussid and alkali it produces a red-violet color, which changes to blue with acetic acid (Legal).

Skatole, C_9H_9N, is β-methyl-indole. It accompanies indole in the intestinal contents and in fæces, in which it is the more abundant of the two, and is also formed during putrefaction of the proteins, or by the action upon them of caustic potash in fusion. It crystallizes in brilliant plates, fusing point 95°, insoluble in cold water, less soluble than indole in boiling water, soluble in alcohol and in ether, has a strong fæcal odor. Its solution in concentrated hydrochloric acid is violet. Its solution in sulfuric acid is colored deep purple when heated. It forms a red, crystalline compound with picric acid. It does not give the pine-shaving reaction, nor the red color with acid and nitrite, and with Legal's reaction the alkaline solution is yellow, and turns violet with acetic acid and heat. Like indole, it is in part reabsorbed from the intestine and eliminated with the urine in combination with sulfuric and glucuronic acids. Neither indole nor skatole has any notably toxic action.

Ptomaïns of Unknown Constitution.—*Morrhuin*, $C_{19}H_{27}N_3$, and *asellin*, $C_{25}H_{28}N_4$, are two of the six bases obtained by Gautier and Mourgues from brown cod-liver oil, the former constituting about one-third of the total, and the latter a small fraction. *Morrhuin* is a thick, yellowish liquid, having the odor of hawthorn and of lilac, lighter than water, in which it is sparingly soluble, strongly alkaline and caustic, and absorbs carbon dioxid from air. Its hydrochlorid is very deliquescent. Its platinochlorid crystallizes in needles, soluble in water, and is decomposed by heat. Its aurochlorid is soluble in water. It is non-poisonous, but is an active diuretic. *Asellin* is an amorphous, white solid, odorless in the cold, but fusing and giving off an aromatic odor when heated. It is almost insoluble in water, soluble in alcohol and in ether, alkaline, and bitter in taste. Its

salts are soluble in water. Its hydrochlorid is crystalline; its platinochlorid and aurochlorid are unstable. In small doses it produces disturbances of respiration and stupor, and in larger doses convulsions and death. Possibly the former, or both, of these bases may be complex amido acids.

Scombrin, $C_{17}H_{38}N_4$, (not to be confounded with the protamin of the same name obtained from the milt of the mackerel) was obtained in very small quantity by Gautier and Etard from the mother liquors of their alkaloidal bases, above referred to. Its hydrochlorid crystallizes in needles, soluble in water, which decompose slowly at 100°, giving off an odor of lilac. Its platinochlorid crystallizes in light yellow needles, and is soluble in water.

Brieger's base, $C_6H_{13}NO_2$, isomeric with mydatoxin and with leucin, and probably a betaïn, was obtained from tetanus cultures, and is formed by decomposition of tetanin, $C_{13}H_{30}N_2O_4$. Its platinochlorid crystallizes in plates, soluble in water and in alcohol, fusing point 197,° at which temperature it decomposes.

Brieger's bases, $C_7H_{17}NO_2$. Brieger has described three bases having this composition: *Gadinin*, from putrid fish, after five days; *typhotoxin*, from cultures of the Koch-Eberth bacillus; and an unnamed base from horseflesh after prolonged putrefaction at low temperature with limited access of air.

Gadinin (not to be confounded with the brown substance of the same name obtained by De Jongh from cod-liver oil), obtained from the mother liquors of Brieger's "muscarin," forms a hydrochlorid which crystallizes in thick needles, soluble in water, insoluble in alcohol. Its platinochlorid crystallizes in scales, sparingly soluble in water. It forms no aurochlorid. It appears to be non-poisonous.

Typhotoxin is a strongly alkaline base. Its hydrochlorid is deliquescent. Its platinochlorid crystallizes in needles, easily soluble in water. Its aurochlorid crystallizes in prisms, difficultly soluble in water, fusing point 176°. It forms a difficultly soluble picrate. With Ehrlich's reagent (sulfodiazobenzene) it immediately gives a yellow color, which is discharged by bases. In moderate doses typhotoxin causes increased flow of saliva, and acceleration of respiration. Later there is loss of control of the muscles of the extremities, without true paralysis, the animal falling upon its side. The pupils gradually dilate widely, and become insensible. Convulsions do not occur. The frequency of the heart's action and respiration gradually diminishes. During the entire poisoning there is copious diarrhœa. After death the heart is found contracted in systole, the lungs are highly hyperæmic, the other organs pale. The intestines are strongly contracted, and their walls pale.

The unnamed base, $C_7H_{17}NO_2$, crystallizes in very deliquescent plates, and has a faintly acid reaction, but it does not form salts with bases, and does not respond with Hofmeister's reaction with ferric chlorid. It is not an amido acid. Its hydrochlorid crystallizes in needles, insoluble in absolute alcohol. Its aurochlorid crystallizes in plates or in needles, difficultly soluble in water, fusing point 176°. It does not react with Ehrlich's reaction, and forms no picrate. It has the physiological action of curare. A base having this composition has also been obtained by Baginsky and Stadthagen from cultures of a bacillus allied to the Finkler-Prior spirillum.

Tetanin, $C_{13}H_{30}N_2O_4$.—Brieger, in his earlier experiments with cultures of an anaërobic bacillus found by Nicolaier in earth samples, and capable of producing symptoms of traumatic tetanus in animals, and with cultures of the same bacillus bred by Rosenbach from the wound of a man who died with tetanus, obtained two bases with a similar physiological action—tetanin and tetanotoxin.

Tetanin is a yellow, strongly alkaline syrup, which gives no blue color with ferric chlorid and potassium ferricyanid. Its hydrochlorid is deliquescent, and forms an easily soluble, crystalline compound with phosphomolybdic acid. Its platinochlorid crystallizes from alcohol in light yellow plates, very soluble in water. The free base, or its hydrochlorid, when injected into mice or guinea-pigs, soon causes clonic or tonic convulsions of the greatest intensity, which terminate in death. The course of the poisoning is divisible into two stages: In the first the animal is depressed and lethargic, then it suddenly becomes uneasy, and the diaphragm contracts energetically. The second is marked by convulsions, usually tonic, but occasionally clonic. Death occurs frequently in a violent convulsion. Frogs withstand the action of the poison better than warm-blooded animals, but when they succumb they become perfectly rigid in a position of pronounced opisthotonos. Guinea-pigs, when thoroughly under the influence of the poison, exhibit very clearly the characteristic spasms of tetanus in the human subject and marked opisthotonos.

Tetanotoxin, $C_5H_{11}N$(?), is a volatile substance, boiling at 100°. In relatively large doses it produces in animals fibrillar contractions of diverse groups of muscles, particularly those of the neck and face. Motion is more or less interfered with, until paralysis is established. Convulsions increase in intensity, attacking groups of muscles very violently. The animal lies with the head thrown back and the extremities extended, and, when pressed upon, makes movements as in swimming. Finally the animal falls upon its side, and dies in a violent convulsion.

Two other bases have subsequently been obtained by Brieger from cultures of the tetanus bacillus, both of unknown composition.

Spasmotoxin, which forms a soluble platinochlorid, fusing point 210°, causes violent tonic and clonic convulsions in animals. The other base, unnamed, forms a very deliquescent hydrochlorid; a platinochlorid which crystallizes in scales, decomposed at 240°; and a very soluble aurochlorid and picrate. It produces complete tetanus, salivation, and lachrymation in animals.

It is not surprising that when the physiological action of these bases was first recognized they were considered to be the specific poisons produced by the bacillus of tetanus. But it has been shown that the filtered culture is vastly more active than the combined bases, and that the culture contains a non-basic, non-albuminous toxin, which, still in an impure condition, has a lethal toxicity estimated at 0.23 mgm. for the human subject. Therefore, while the bases above mentioned undoubtedly have some action in producing the manifestation of tetanus, such action is greatly subordinate to that of the toxin.

Lepierre's base, $C_{16}H_{23}N_2O_4$, obtained in small amount from poisonous cheese, is crystalline, odorless, bitter, faintly acid, and sparingly soluble in water. Its hydrochlorid crystallizes in needles, very soluble in water. Its platinochlorid and aurochlorid are crystalline. It causes diarrhœa in guinea-pigs.

Delézinier's base, $C_{32}H_{31}N$ or $C_{34}H_{33}N$ (?), whose composition is quite uncertain, is an almost colorless, oily liquid, very sparingly soluble in water, soluble in alcohol, ether, and benzene, rapidly oxidized in air, and forming deliquescent salts. It is supposed to be identical with a base obtained by Brouardel and Boutmy, which bore some resemblance to veratrin.

Susotoxin, $C_{16}H_{26}N_2$ (?), a base whose hydrochlorid was obtained by Novy from cultures of the hog-cholera bacillus. The free base was not isolated. The hydrochlorid is a light yellow syrup which does not crystallize, somewhat hygroscopic, and soluble in water and in alcohol. It gives off an amin odor when heated with fixed alkali. Its platinochlorid is granular and light flesh colored, or crystallizes in long, thick needles, soluble in water, from which it is precipitated by alcohol. It is toxic only in large doses. It is said to be identical with the *sucolotoxin* of von Schweinitz.

Pyocyanin, $C_{14}H_{14}NO_2$ (?), is the coloring matter of blue pus, first obtained by Fordos. It crystallizes in blue prisms or scales, soluble in water, alcohol, and chloroform, less soluble in ether. Its blue aqueous solution is neutral, and is changed to cherry-red by acids, and back to blue by alkalies. It is oxidized in air to the yellow *pioxanthose*, which also accompanies it in the pus. According to Kunz, it contains sulfur. It is supposed to be an anthracene derivative.

Anthracin is the name given by Hoffa to a base, $C_5H_6N_2$ (?) obtained from cultures of the anthrax bacillus.

The following bases are of unknown composition:

A base obtained by Brieger from human livers and spleens after two weeks' putrefaction with free access of air. Its hydrochlorid crystallizes in small, deliquescent needles; and its platinochlorid in fine needles, containing 41.30 per cent. of platinum. It causes long-continued diarrhœa in rabbits and guinea-pigs.

Another base obtained by Brieger from the same source; fluorescent, boiling point about 284°, whose hydrochlorid crystallizes in long needles, soluble in absolute alcohol. Its platinochlorid crystallizes in fine needles, very soluble in water, or in plates, containing 30.36 per cent. Pt.

A base obtained by Brieger from putrid fish. Its hydrochlorid and platinochlorid crystallize in small needles; the latter containing 36.03 per cent. Pt and 7.81 per cent. N.

A base obtained by Bocklisch from herring after twelve days of putrefaction, whose platinochlorid crystallizes in large, thin plates, easily soluble in water, and containing 28.57 per cent. Pt.

Peptotoxin is the name given by Brieger to a toxic substance (or mixture of substances) having some of the characters of the nitrogenous bases, obtained from peptone, produced by the action of pepsin from the pig upon fresh fibrin. The same body was obtained from Witte's peptone, and from putrefying fibrin, casein, and brain, liver, and muscular tissues. If putrefaction has continued for eight days, it is no longer obtainable. It crystallizes with difficulty, passes from both acid and alkaline solutions into amylic alcohol, is insoluble in ether, benzene, or chloroform, but very soluble in water. Its solutions are neutral. It is quite stable, and is not decomposed by boiling, or by treatment with hydrogen sulfid or with caustic alkalies. With Millon's reagent it gives a white precipitate, which turns bright red on the application of heat. It precipitates with many of the general reagents for alkaloids, and gives the blue reaction with freric chlorid and potassium ferricyanid. It is actively poisonous in small doses, causing paralysis of the posterior extremities, sopor, and death.

Phlogosin is the name given by Leber to a substance which is probably not a base, obtained from cultures of staphylococcus aureus. It crystallizes in needles, soluble in alcohol and in ether, sparingly soluble in water, and may be sublimed. It forms no compound with platinic or auric chlorid, and does not precipitate with phosphotungstic, phosphomolybdic, picric, or tannic acid. It appears to contain sulfur and no nitrogen.

Tyrotoxicon is the name given by Vaughan to a material extracted from poisonous cheese, whose chemical characters are not well defined.

The individual existence of the numerous bases described by Griffiths requires confirmation.

Nitrogenous bases are also formed during alcoholic fermentation. These are not properly ptomaïns, being produced by yeast fungi, which are not bacteria.

Morin's base, $C_7H_{10}N_2$, is the best known of these. It was obtained from the fraction of crude fusel oil, distilling at 171°–172°. It is a colorless, mobile, oily liquid, having a nauseous odor, spec. grav. 0.9826, not alkaline in reaction. Its hydrochlorid forms needles, soluble in water and in alcohol, very sparingly soluble in ether. Its platinochlorid is crystalline, soluble in water and in alcohol, very sparingly soluble in ether. It is decomposed by hot hydrochloric acid, with formation of ammonia. It combines with ethyl iodid to form a yellow, crystalline compound, very soluble in alcohol and in water, very sparingly soluble in ether. Its aqueous solution does not precipitate with Mayer's reagent, but on acidulation with hydrochloric acid there forms a flocculent, yellow precipitate, which unites into long, brilliant, yellow needles—a reaction which is not given by the pyridic or quinolinic bases. It is poisonous, and in rabbits causes stupor and paralysis, beginning with the posterior extremities, diminished sensibility, dilatation and insensibility of the pupils, diminution of the temperature and cardiac action, and death in coma. This base is probably identical with Tanret's *glucosin*, obtained by the action of ammonia and ammonium salts upon glucose.

Oser's base, $C_{13}H_{20}N_4$, is produced during the fermentation of pure saccharose by yeast. It is not volatile, and is decomposed when heated with acids. Its hydrochlorid is very hygroscopic, very unstable, and turns brown in air. Its aurochlorid is a yellow, flocculent precipitate, which becomes crystalline, and is very sparingly soluble in water.

A base, said to be pyridin, has been found in commercial alcohol by Haitinger and by Guareschi and Mosso to the amount of 0.4 to 0.5 in 1,000. Schrötter has described two bases, $C_8H_{12}N_2$ and $C_{10}H_{16}N_2$, obtained from the fraction of molasses-fusel distilling at 180–233°. Krämer and Pinner obtained bases, which they considered to be pyridic, from commercial alcohol. Other imperfectly defined bases have been described as existing in beer or in distilled spirits by Surgères, Lindet, Modermann, Lermer, von Geldern, Dannenberg, Meyer, and Fassbender and Schoepp.

Pouchet's bases, $C_5H_{12}N_2O_4$ and $C_7H_{18}N_2O_6$, cannot be regarded as ptomaïns, as they were obtained from the liquid residues of an industrial process of treatment of bones, flesh, and other animal refuse by sulfuric acid, and the action of the acid was undoubtedly a factor in their production.

The ptomaïns and basic products of yeast fungi above described are split products of protein material, eliminated by the organisms producing them, and not constituents of those organisms. The distinction between constituent and excretory bacterial products is one of importance biologically and pathologically, but is one which is undesirable from the point of view of analytical toxicology, because the bacteria, as well as their elimination products, are present in materials submitted to analysis, and, although the entire bacteria do not give up their constituent substances to solvents by any means as readily as they do after comminution by Koch's method, they do so to a certain extent.

The only instance of the formation of a protamin by bacteria of which we have knowledge, is the *tuberculosamin* of Ruppel, which he obtained from the tubercle bacilli, but not from their cultures. It is, therefore, a constituent of their organism, in which it exists in combination with a nucleic acid, and not an elimination product. Tuberculosamin has the properties of the protamins: it is extracted by cold, dilute sulfuric acid (one per cent.), is precipitated from neutral solution of the sulfate by sodium picrate, forms an alkaline solution in water, is strongly basic, does not give the color reactions of the proteins except the biuret reaction, contains no phosphorus, and precipitates the proteins from ammoniacal solutions. The protamins form precipitates with phosphotungstic acid, Mayer's reagent, and other general reagents for alkaloids. They are actively poisonous, causing at first acceleration, then slowing of the respiration, marked diminution of the blood pressure, and death.

Chemico-Legal Considerations.—The ptomaïns are now mainly of interest in connection with forensic toxicology. From the first discovery of these substances, and until their chemistry and that of the vegetable alkaloids became better known, it was feared that their existence might seriously interfere with or entirely prevent the detection of vegetable alkaloids, with sufficient certainty for the purposes of justice, in cases of criminal poisoning. The ptomaïns were called "putrid alkaloids," were considered to be of the same chemical class as the vegetable alkaloids, and almost all were found to respond to many of the general tests for the alkaloids. In short, everything seemed to point to a much closer rela-

tionship between the ptomaïns and the vegetable bases than that which actually exists. But the development of the chemistry of the ptomaïns has shown that those of them which have the most complex molecular structure are more simple in constitution than their nearest relatives among the vegetable alkaloids, and very much more simple than the ester-alkaloids, such as atropin, or the still more complex polynuclear alkaloids, such as morphin.

While the parasitic bacteria probably cause synthetic combinations, as in the generation of the toxins, the function of the saprophytic bacteria, which alone are of interest in this connection, is essentially analytical. It may be considered to be within the limits of possibility that, starting with the complex protein molecule, a substance having the constitution of a vegetable alkaloid might be produced during the series of hydrolytic decompositions caused by the saprophytes. But all observations are against such an hypothesis, no such substance has been found among all of the putrid products which have been obtained. Moreover, the known products of decomposition of the proteins by other means, through the protamins, the hexon bases, the nucleins, the purin bases, the amido acids, and the amins, lead in a direction not tending to the formation of the alkaloids, except in the case of the formation of the pyridic bases by the action of heat. The formation, however, of pyridic and, particularly, of hydropyridic ptomaïns as late products of putrefaction indicates the possibility that the analytical processes of the saprophytes may be followed by the transformation of certain of the acyclic products into heterocyclic compounds, in a manner similar to the conversion of pentamethylene hydrochlorid (cadaverin) into piperidin: $H_2N.(CH_2)_5.NH_2 : HCl = NH_4Cl + C_5H_{11}N$.

No ptomaïn has been discovered which corresponds in all of its characters with a vegetable alkaloid. Two substances alike in all respects are two samples of the same substance, and no vegetable alkaloid is known which is also a product of putrefaction. But there are certain vegetable alkaloids which resemble certain ptomaïns in several of their properties, while differing in others, and, at the same time, exhibit no known well-marked and distinctive chemical reactions. Probably the closest resemblance is that between the so-called cadaveric coniïn and true coniïn. Both are liquid, oily, volatile, intensely alkaline, similar in odor, soluble in water and in petroleum ether, and form precipitates with platinic chlorid, auric chlorid, mercuric chlorid, and several of the general reagents. They differ in that coniïn is actively poisonous, while the ptomaïn has been found to be inert, except in one case in which Otto obtained a poisonous substance, which probably owed its toxicity to the presence of another ptomaïn. The "cadaveric coniïn" is, however, not coniïn (*a*-propyl piperidin) but cadaverin (pentamethylenediamin). Therefore, while it must be admitted that we have no method to separate coniïn from a putrid cadaver, and, in the minute quantity in which it would probably be obtained, distinguish it from cadaverin, or from a mixture of ptomaïns containing cadaverin; it may also be anticipated, the two substances not being identical, that distinguishing characters of sufficient delicacy will be found to exist.

Attempts have been made to find a characterizing reaction common to all ptomaïns, whereby they might be distinguished from the vegetable alkaloids. Among those suggested were the reactions of Brouardel and Boutmy, and of Trotarelli. But no such reaction can exist, because the ptomaïns do not constitute a distinct chemical class, but include among their number representatives of several chemical classes of tolerably diverse character; and for the further reason that, while the great majority of ptomaïns are non-alkaloidal, some are pyridin or hydropyridin derivatives, as are also the alkaloids. As the "general tests" for the alkaloids for the most part form precipitates with ptomaïns, albumins, and nitrogenized bases other than alkaloids, they are only of negative value in the rare cases in which they fail to react, or of confirmatory value by reason of peculiarities in the qualities of the precipitates which they produce with certain alkaloids.

The ptomaïns which are frequently referred to as "strychnin-like" or "morphin-like" are quite as noticeable because of the differences from those alkaloids which they present, as by reason of their resemblances thereto.

The bases obtained by Brieger from the cultures of the tetanus bacillus, while resembling strychnin in the production of tetanic spasms, differ from the alkaloid in not giving the color reaction, in not being bitter, and in crystalline form. Amthor's product was neither bitter nor crystalline, nor did it give the color reaction of strychnin, but an entirely different one. In Ciotto's case the material supposed to have been strychnin appears to have given the color reaction, as Selmi, who differed from Ciotto in his conclusions from the observed facts, concedes this much. But the colors obtained are not described beyond the statement that they were "the colors proper to the reaction of strychnin," and Selmi, in the course of the same paper, says that aspidospermin "behaves with bichromate as does strychnin," while in fact there are marked differences between the color reactions of strychnin and of aspidospermin under like treatment. But Ciotto's substance was not shown to be either crystalline, alkaline, or distinctly bitter, and when administered to frogs in quantity sufficient to kill them it did not cause tetanic spasms. Lombroso and Dupré obtained from the spoiled maize which is regarded as the cause of pellagra a mixture of bases (pellagrozein) which is bitter in taste, causes tetanus in frogs, and is said to give the color reaction of strychnin, but whose reaction only resembles that of strychnin in its initial stage. It also differs from strychnin in its crystalline form, and in that its sulfuric-acid solution assumes a permanent violet color when exposed to vapor of bromin. But pellagra is confined to a comparatively narrow strip of territory (six degrees) in the south of Europe. Moreover it is not proven that the constituents of pellagrozein are bacterial products; certainly they are not cadaveric ptomaïns.

We find reference in toxicological literature to alleged "morphin-like" ptomaïns in three cases. In the Sonsogno case, in Italy, the substance mistaken for morphin did not give either the Pellagri reaction, the ferric-chlorid reaction, the nitric-acid reaction, or the Erdmann reaction; and it only resembled morphin in that it behaved as a reducing agent toward iodic acid, auric chlorid, and certain other reducible substances. In the Portuguese case of Urbino de Freitas not one of the three most nearly characteristic of the tests for morphin, the Pellagri, the Husemann, and the ferric chlorid was even tried, and the experts erred in asserting the presence of morphin in a cadaver upon the evidence of a not entirely satisfactory Fröhde reaction, the iodic reaction, and the formation of a green color with the Lafon test, the last a reagent whose merits had been insufficiently tested. In the Buchanan case in New York, Vaughan makes the unwarranted assertion that "all the tests obtained by the experts were duplicated with putrefactive products." This alleged duplication was attempted in open court, in the presence of the author, with the following results: The ferric chlorid gave a brilliant grass-green, not a blue color. The Husemann was improperly applied, and failed, as it would have done had morphin been present. The Pellagri was also improperly applied, and failed, as it would have failed with morphin in the manner in which it was used. The Fröhde gave a distinct orange color, passing to yellow, in place of the purple, passing through blue, dirty green, and yellow to pink as it gives with morphin. The nitric acid gave an immediate yellow, but not the orange-red changing to yellow of morphin. The iodic acid gave a faint reaction similar to that obtained with morphin and with many other reducing agents. The six "duplications" therefore consisted of five failures to produce similarity, and one faint resemblance.

Whether a vegetable alkaloid is detectable in cadaveric material or no depends now, as it did before our knowledge of the existence of the ptomaïns was gained, upon the existence or non-existence of a sufficient number of well-marked physical qualities, chemical reactions, or physiological actions of that alkaloid. If such exist, and are not duplicated or interfered with by ptomaïns, the alkaloid may be detected with certainty. If they do not, it cannot be, ptomaïn or no ptomaïn. In the frequently cited case of General Gibbone in Rome, it was shown by Selmi that the substance which was claimed to have been delphinin could not be that alkaloid, because it did not have its physiological action. But this affirmative proof was simply confirmative of the already convincing argument that delphinin has no physical characters and gives no chemical reactions which are sufficiently distinctive to permit of its identification when present in the minute quantity obtainable in such an analysis.

That the presence of ptomaïns may militate against the detection of a vegetable alkaloid, both by interference with its reactions and by similarity of its physiological action, is well shown in the case of atropin. From the viscera of a woman, after nine months' burial, the author obtained a residue (which would have contained atropin had it been present) which caused wide dilatation of the pupil and insensibility to light, persisting for several hours, gave the peculiar crystals with bromin in hydrobromic acid, and reddened phenolphthalein; but did not produce Kratter's crystals, or respond to the Vitali reaction. But portions of the same residue, to which atropin sulfate was added in notable proportion, also failed to give the Vitali reaction.

While, therefore, the presence of ptomaïns may interfere to prevent the detection of certain alkaloids which may be actually present in the materials examined, we know of no instance in which a ptomaïn or mixture of ptomaïns has given reactions which would cause it to be mistaken for an alkaloid possessed of sufficiently distinctive characteristics to permit of its certain identification in the assured absence of all ptomaïns. A survey of the reactions manifested by the reputed "alkaloid-like" ptomaïns shows that their similarities to those of the vegetable alkaloids consist chiefly in resemblances of physiological action, and in their behavior toward "general reagents" and toward iodic acid. We have stated above that the general reagents play only a very secondary rôle in the identification of vegetable alkaloids, and iodic acid is merely a test for reducing agents, which is used for morphin because the reducing action of that alkaloid is one of the characters which differentiates it from most of the other vegetable bases. If we except one veratrin reaction obtained by Brouardel and Boutmy, the somewhat doubtful case of Ciotto mentioned above, and the statements of Vaughan, there is no reference in toxicological literature to a ptomaïn which has given a well-characterized reaction of a vegetable alkaloid.

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PTYALIN. See *Saliva*.

PTYALISM. See *Mouth, Diseases of*, in THE APPENDIX.

PUBERTY.—DEFINITION.—The term puberty was formerly used to designate the whole period of sexual development, and is still occasionally so used. Jules Voisin[1] refers to the age of puberty as the time between the ages of fourteen and twenty-two years. In general, however, writers now confine the term puberty to the initiatory and formative period of sexual development, while to the entire period of sexual development is applied the broader term adolescence.

The Age of Puberty.—The average age of puberty in the male is 14.3 years; the average age of first menstruation in the female is about 13.7 years. The period differs according to race and climate, and may be hastened by the reading of erotic literature, by suggestion, and by an early participation in social life.

The pubescent period begins in girls at least a year and a half before the first menstruation. This preliminary period is, according to Armand Delpeuch,[2] the time when the child needs the greatest care, for at this time the trunk is relatively the shortest, the thorax relatively the narrowest, and the heart relatively the smallest, and at the same time the child is doing his most rapid growing. The female makes the most rapid growth from twelve to fourteen, and the male from fourteen to seventeen. The pubescent child should, therefore, be guarded against too violent exercise, and yet should be provided with much pure air.

Physical Changes.—A general physical disturbance takes place, shown by the rapid bodily growth, the elongation of the vocal cords, increased pilosity, a change in the size and condition of the reproductive organs, and a profound disturbance of the nervous system. Indeed, muscles, blood-vessels, glands, and all organs share in the general disturbance.

Psychical Changes.—The psychical no less than the physical being is affected by puberty. Marro of Turin[3] says that "puberty exercises a notable influence upon the psychical life, which is manifested, in some instances, by giving to mental symptoms qualities which they did not have before or which they had only to a slight degree, and in others by preparing a way for the invasion of psychoses. Hereditary predisposition is the prominent cause of the affection."

Periodic Phenomena.—The most notable accompaniment of puberty in the female is *menstruation* (which see). In the male there is throughout sexual life and beginning with puberty a periodicity which is probably analogous to that of the female. The seminal vesicles possess glandular walls and retain the secretion of these walls for periods varying from one to four weeks normally.

The retained secretion distends the walls, and through pressure stimulates nerves which pass to the erection centre, which is in turn excited.

By day erotic emotions are easily aroused; at night when the subject sleeps he may experience an erection accompanied by an erotic dream and culminating in an emission ("nocturnal emission"). In this way is the pressure of accumulating vesicular secretion relieved and the subject should pass another period free from sexual impulses. After the period of pubescence is established, the testes of the male form spermatozoa rapidly under sexual excitement and slowly during periods which are free from excitement. In neither case do the spermatozoa pass into the seminal vesicles; they are retained in the testes, the vasa deferentia, and ampullæ. The testes form not only the spermatozoa but a milky fluid in which the spermatozoa float. The secretion of the testes contains a mysterious principle whose reabsorption gives to the male those characteristics which we recognize as distinctive of virility. In the nocturnal emission coming without sexual excitement no spermatozoa are lost; hence these emissions cause no depletion. *J. W. Hall.*

[1] St. Louis Med. Review, October 13th, 1901.
[2] La Presse méd., August 17th, 1898.
[3] St. Louis Med. Review, October 13th, 1901.

PUERPERAL INFECTION.—(Puerperal fever, puerperal sepsis, puerperal septicæmia, childbed fever.)

DEFINITION.—An acute contagious disease of the puerperium characterized by an inflammation of some part of the genital tract, and frequently associated with a variety of systemic manifestations. It is caused by a number of pathogenic and saprophytic micro-organisms.

HISTORY.—The disease has been known from the earliest times. Hippocrates, Galen, Avicenna, and others of the early writers, as well as many in the sixteenth, seventeenth, and eighteenth centuries, have described cases. In the first half of the nineteenth century there were many frightful epidemics of the disease.[1] It was the scourge of the great lying-in hospitals of Europe, and patients were decimated regularly by its ravages. Oliver Wendell Holmes in his essay, "The Contagiousness of Puerperal Fever," published in 1843, logically proved the contagious nature of the disease; and Ignaz Philipp Semmelweiss, who recognized the identity of the disease with wound infection and devised a practical method