careful dehydration experiments which show that salts can be dehydrated completely without decomposing the anions. Techniques were similar to those utilized for other compounds.[9,10,11] (b and c) The tetrahedral central grouping is unequivocally supported by the paramagnetic susceptibilities and absorption spectra.[6] (d) Unlike many octahedral cobaltic complexes,[12] the 12-tungstocobaltiate is reduced reversibly and practically instantaneously to the cobaltous complex. Various potentiometric titrations establish the formal oxidation potential in *N* H_2SO_4 as −1.0 volt. Extrapolated potentials of mixtures in pure water yield the same result. Thus the coördination provides relatively small stabilization for the +3 oxidation state. These observations are consequences of the tetrahedral coördination or, conversely, they support that configuration.[6] (e) Using single crystal X-ray techniques, a detailed structure for potassium 12-tungstocobaltiate has been determined in this laboratory by Klaas Eriks, Nicholas F. Yannoni, and ourselves. Every atom in the anion is unambiguously located. The anions are discrete and slightly squeezed in one direction in that salt.

These results[13] show that the simplest relationship exists between the condition of these heteropoly electrolytes in solution and in the solid state. This point has caused concern to many investigators of heteropoly electrolytes.

(9) L. C. W. Baker and T. P. McCutcheon, *Anal. Chem.*, **27**, 1625 (1955).

(10) L. C. W. Baker, B. Loev and T. P. McCutcheon, THIS JOURNAL, **72**, 2374 (1950); L. C. W. Baker, G. A. Gallagher and T. P. McCutcheon, *ibid.*, **75**, 2493 (1953).

(11) L. C. W. Baker, *et al.*, *ibid.*, **77**, 2136 (1955).

(12) L. E. Orgel, *Inst. intern. Chim. Solvay*, **10e** *Conseil Chim. Brussels*, 289 (1956).

(13) Detalled measurements of the magnetic susceptibilities, spectra, and x-ray crystal structure are well advanced for the two dicobalt anions mentioned in the first paragraph. These will be the subjects of other papers.

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SYNTHESIS OF AN OPTICALLY ACTIVE *myo*-INOSITOL 1-PHOSPHATE

Sir:

In a recent paper[1] the characterization of *myo*-inositol 1-phosphate resulting from the base hydrolysis of soybean phosphoinositide was reported. This natural substance showed $[\alpha]_D$ + 3.4° (*p*H 9, water) and $[\alpha]_D$ −9.8° (*p*H 2, water), and, partly because of this optical activity, we concluded that the diacyl glycerol phosphate moiety in the original phosphoinositide must have been linked to the 1-position of the *myo*-inositol ring.

It can be argued that the optical activity observed was so small that it may have been due to an impurity. To check this point, we have carried out the synthesis of an *asymmetric myo*-inositol 1 - phosphate. The starting material was galactinol,[2] which has been shown to be 1-*O*-α-D-galactopyranosyl *myo*-inositol.[3] Complete benzylation of this compound, and then methanolysis of the galactosidic linkage, gave 2,3,4,5,6-penta-*O*-benzyl *myo*-inositol. Phosphorylation of this product with diphenyl phosphorochloridate and hydrogenolytic removal of the benzyl and phenyl groups gave a *myo*-inositol 1-phosphate which was isolated as a crystalline cyclohexylamine salt. *Anal.* Calcd. for $C_{18}H_{39}O_9N_2P$: N, 6.1; P, 6.8. Found: N, 5.7; P, 6.6. The substance showed $[\alpha]_D$ −3.2° (*p*H 9, water) and $[\alpha]_D$ +9.3° (*p*H 2, water). Its infrared spectrum (KBr pellet) and chromatographic properties were identical with those of the substance isolated from soybean phosphoinositide. Thus, this synthetic compound is the enantiomorph of the soybean compound, and the good check between the rotations of the two establishes the optical purity of the latter. This result, coupled with the recent work of Brockerhoff and Hanahan,[4] leaves little doubt that the *myo*-inositol portion of soybean phosphoinositide is substituted in one of its enantiomeric 1-positions.

The absolute configuration of the 1-position of *myo*-inositol to which the galactosyl unit is attached in galactinol is known, and was shown[3] to be that one which by inversion leads to (−)-inositol. Thus, the absolute configurations in the two enantiomeric *myo*-inositol 1-phosphates also are now established, and are represented by the formulas

Synthetic compound Soybean compound

Although there is no generally accepted convention by which one can assign configurational names to these isomers, the proposal of Lardy[5] would lead to designating the synthetic compound as D-*myo*-inositol 1-phosphate and the one from soybean phosphoinositide as L-*myo*-inositol 1-phosphate.

(1) F. L. Pizer and C. E. Ballou, THIS JOURNAL, **81**, 915 (1959).

(2) R. J. Brown and R. F. Serro, *ibid.*, **75**, 1040 (1953).

(3) E. A. Kabat, D. L. MacDonald, C. E. Ballou and H. O. L. Fischer, *ibid.*, **75**, 4507 (1953).

(4) H. Brockerhoff and D. J. Hanahan, *ibid.*, **81**, 2591 (1959).

(5) H. A. Lardy, in "The Vitamins," Vol. II, edited by W. H. Sebrell, Jr., and R. S. Harris, Academic Press, Inc., New York, N. Y., 1954, p. 325.

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VINCA ALKALOIDS.[1] IV. STRUCTURAL FEATURES OF LEUROSINE AND VINCALEUKOBLASTINE, REPRESENTATIVES OF A NEW TYPE OF INDOLE-INDOLINE ALKALOIDS

Sir:

In the preceding communication[1] we were able to demonstrate that the new alkaloids, leurosine and vincaleukoblastine, probably are isomeric $C_{46}H_{58}O_9N_4$ compounds. The spectral properties of the two compounds indicated striking similarities in their structures. We wish to present evidence that these two compounds are representatives of a new class of dimeric alkaloids containing both indole and dihydroindole moieties.

(1) Vinca Alkaloids. III. N. Neuss, M. Gorman, G. H. Svoboda, G. Maclak and C. T. Beer, THIS JOURNAL, **81**, 4754 (1959).

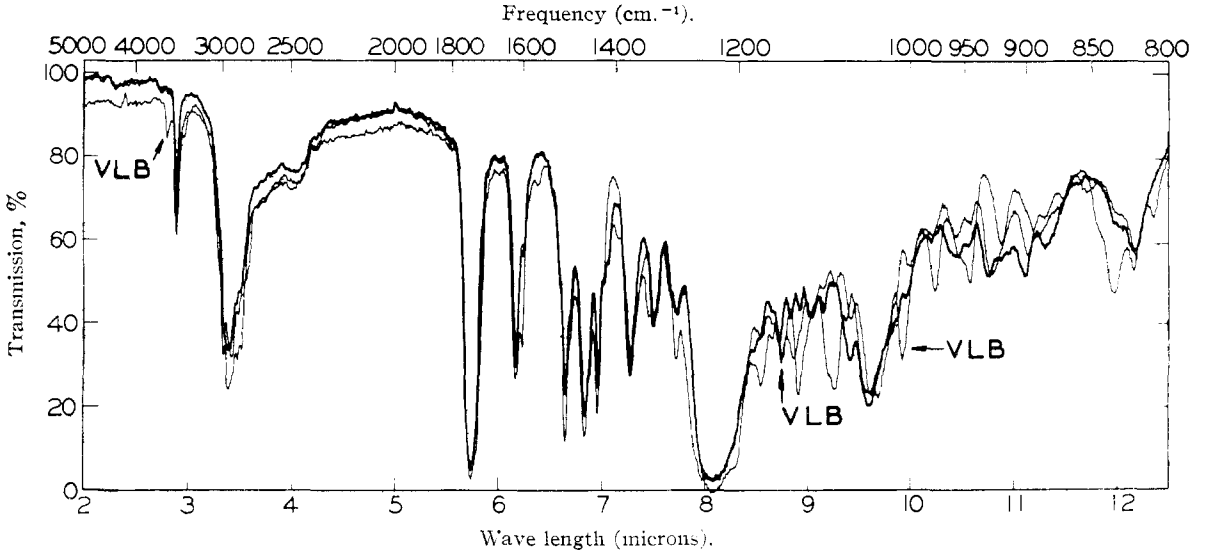

Fig. 1.— —— Leurosine; →/vincaleukoblastine; ——equimolar solution of catharanthine and vindoline.

Recently we have reported the characterization[2] and partial structures of catharanthine and vindoline, two new alkaloids from *Vinca rosea Linn.* Catharanthine was shown to be a $C_{21}H_{24}O_2N_2$, pentacyclic ester *indole* alkaloid (I) and vindoline a $C_{25}H_{32}O_6N_2$ pentacyclic *dihydroindole* compound (II). Similarities in the infrared spectra of these

I $C_{19}H_{21}N_2$ {COOCH$_3$} II $C_{20}H_{22}N_2$ {COOCH$_3$, OCOCH$_3$, OCH$_3$, OH}

two compounds and leurosine and vincaleukoblastine prompted us to use the infrared summation technique which proved successful in the deduction of structural features of reserpine[3] and other *Rauwolfia* alkaloids.[4]

Comparison of the infrared spectra of an equimolar solution of vindoline and catharanthine with that of leurosine (or vincaleukoblastine) showed an excellent agreement of wave lengths and intensities of bands in the portion of the spectra between 2.90–8.1 μ in chloroform solution.[5] This region defines the identity of the aromatic portions of the molecules (including the substitution on aromatic rings) as well as alicyclic ring systems. The oxygen functions of the monomeric alkaloids catharanthine and vindoline 2($COOCH_3$), 1($OCOCH_3$), 1(OCH_3), OH and the indole NH are present in the dimeric compounds (Fig. 1).

These assignments were corroborated by functional group analyses and n.m.r. spectra.[6] *Leurosine,* Calcd. for $C_{46}H_{58}O_9N_4$: $COCH_3$(1), 5.31; OCH_3(4), 15.31; (N)-CH_3(1), 1.85. Found: $COCH_3$, 4.91; OCH_3, 15.31; (N)-CH_3, 1.43.

Vincaleukoblastine etherate, Calcd. for $C_{46}H_{58}O_9N_4 \cdot (C_2H_5)_2O$: $COCH_3$(1), 4.86; OCH_3(3), OC_2H_5(2), 20.70; (N)-CH_3(1), 1.69. Found: $COCH_3$, 4.62; OCH_3, OC_2H_5, 21.99; (N)-CH_3, 1.28.

Karrer, Schmid and co-workers have postulated the formation of dimeric curare alkaloids from either two strychnine type or two β-carboline type alkaloids bonded through C_{17} and indole nitrogen in the case of β-carboline compounds.[7]

Our results clearly indicate that another variation, namely, an indole and dihydroindole combined in a manner which leaves the indole NH free (*vide supra*) is also possible. While essential structural features of vindoline and catharanthine are clearly present in the molecules of leurosine and vincaleukoblastine, the mode of attachment remains to be elucidated. The question whether vindoline and catharanthine are precursors of these new dimeric compounds or artifacts formed during the processing of the plant material is also under study.

The authors are grateful to Miss Ann Van Camp and Dr. R. Pfeiffer for the molecular weight determination from the X-ray data, Dr. H. E. Boaz for infrared data, Mr. L. G. Howard for ultraviolet data, Messrs. W. L. Brown, R. Hughes, H. L. Hunter, and G. M. Maciak for microanalyses, and Mr. H. Wesselman for the vapor phase chromatograms.

(2) M. Gorman, N. Neuss, G. H. Svoboda, A. J. Barnes, Jr., and N. J. Cone, *J. Am. Pharm. Assoc. Sci. Ed.*, **48**, 256 (1959).

(3) N. Neuss, H. E. Boaz and J. W. Forbes, THIS JOURNAL, **75**, 2463 (1954).

(4) N. Neuss and H. E. Boaz, *J. Org. Chem.*, **22**, 1001 (1957).

(5) The additional bands at 2.80 (OH) and 9.91μ (-C-OH) in the spectrum of vincaleukoblastine were absent from the summation spectrum.

(6) We are grateful to Mr. J. A. Deyrup (University of Illinois) for the n.m.r. spectra.

(7) P. Karrer, "Alkaloids of Calabash Curare and Strychnos Barks in Proceedings of the International Symposium on Curare and Curare-like Agents," Rio de Janeiro, 5–12 August 1957 (Currare and Curare-like Agents," edited by D. Bovet, F. Bovet-Nitti and G. B. Marini-Bettolo, Elsevier Pub. Co., Amsterdam, 1959, p. 125).

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DIRECT SPECTROPHOTOMETRIC EVIDENCE FOR AN ACYL-ENZYME INTERMEDIATE IN THE CHYMOTRYPSIN-CATALYZED HYDROLYSIS OF O-NITROPHENYL CINNAMATE[1]

Sir:

We wish to report the direct spectrophotometric detection of an acyl-enzyme intermediate in a

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