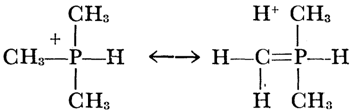
Reports

Effect of Hyperconjugation on Strength of Lewis Bases

The effect on the base strength of substituting methyl groups for hydrogen on nitrogen is an increase of the order of 100-fold in K_b in going from ammonia to trimethylamine (*1*). In going from phosphine to trimethylphosphine (*2*), there is an increase in K_b of the order of 10^{20}. This enormous difference in the effect of a methyl group on the basicity of phosphines compared with amines must be attributed to a type of interaction with a methyl group which is possible with phosphorus but not with nitrogen. Hyperconjugation involving the hydrogens attached to the methyl groups and the empty *d*-orbitals of phosphorus provides a possible answer (*3*). Thus, there are nine equivalent contributing structures that would reduce the positive charge on the phosphorus atom and thereby stabilize the trimethylphosphonium ion.

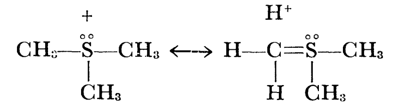


$$CH_3-\overset{+}{\underset{CH_3}{\overset{CH_3}{P}}}-H \longleftrightarrow H-\underset{H}{\overset{H^+}{C}}=\underset{CH_3}{\overset{CH_3}{P}}-H$$

9 equivalent forms

An effect such as this, if present in phosphorus alkyls, might reasonably be expected to be operative in alkyl derivatives of other elements having low-lying vacant orbitals when these elements also carry a formal positive charge. The stabilization of the tertiary butyl carbonium ion by hyperconjugation is an effect well known to organic chemists and need not be discussed here.

Comparison of the basicity of dimethylether and dimethylsulfide toward protonic acids is difficult because of the rearrangement of the sulfide to sulfonium ion in acid solution (*4*). However, the stability of trimethylsulfonium iodide compared with that of the corresponding oxygen compound (*4*) strongly supports the proposed interaction.

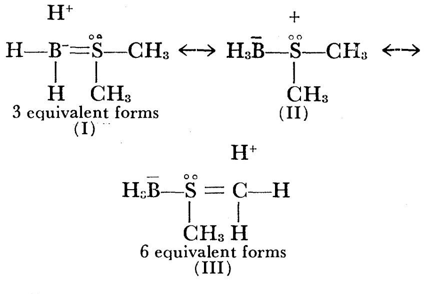


$$CH_3-\underset{CH_3}{\overset{+}{\overset{\circ\circ}{S}}}-CH_3 \longleftrightarrow H-\underset{H}{\overset{H^+}{C}}=\underset{CH_3}{\overset{\circ\circ}{S}}-CH_3$$

9 equivalent forms

The stability of selenonium and telluronium alkyls (*4*) may be attributed to the same type of interaction.

The trimethylsulfonium ion is isoelectronic with the addition compound dimethylsulfide-borine, for which an interaction of the borine group with the empty *d*-orbital of sulfur has been proposed by Graham and Stone to account for its stability relative to the oxygen compound (*5*). These authors, however, did not point out the possible stabilization due to hyperconjugation with the methyl groups.



$$\underset{\text{(I)}}{H-\underset{H}{\overset{H^+}{B^-}}=\underset{CH_3}{\overset{\circ\circ}{S}}-CH_3} \longleftrightarrow \underset{\text{(II)}}{H_3\bar{B}-\underset{CH_3}{\overset{+}{\overset{\circ\circ}{S}}}-CH_3} \longleftrightarrow \underset{\text{(III)}}{H_3\bar{B}-\underset{CH_3}{\overset{\circ\circ}{S}}=\underset{H}{\overset{H^+}{C}}-H}$$

3 equivalent forms (I); (II); 6 equivalent forms (III)

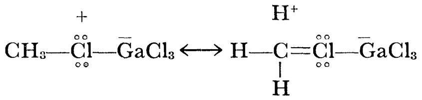
It is not to be implied that structure III is twice as important as structure I since there is greater charge separation in III, but it is felt that structure III will make a significant contribution. The idea that methyl hyperconjugation may be important even when borine groups are present is supported by the large effect of methyl groups on the stability of the arsine-borine compounds (*6*). Hyperconjugation involving the hydrogen attached to the boron has also been proposed in the polymeric arsine-borine compounds to account for the decreased hydridic character of the hydrogen (*6*).

It would appear desirable to check the assumption of hyperconjugation in these systems by replacing the methyl groups with ethyl, isopropyl, and tertiary butyl groups where hyperconjugation should make a successively decreasing contribution. However, studies on such a series might be complicated by steric factors. Thus the rate constants for the reaction of methyl-, ethyl-, propyl, isopropyl, butyl, isobutyl, and tertiarybutylthioglycolic acid with iodoacetic acid have been determined (*7*) and might be interpreted in terms of hyperconjugation, but the data may be interpreted equally well in terms of B- and F-strain (*8*). The observation that dihalogenides are readily formed from sulfides in which the sulfur atom is attached to a methyl or methylene group (*9*) supports the hyperconjugation view, but unfortunately the only data on tertiary substituents were for diaromatic sulfides in which resonance with the aromatic might lower the reactivity of the sulfur.

$$R_2S + X_2 \rightarrow R_2S\overset{+}{X}\,\bar{X}$$

where X is Br or I.

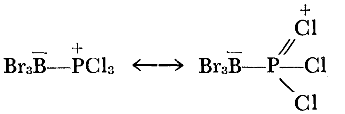
A study has been made on the interaction of the alkyl chlorides with gallium chloride indicating that the order of stabilities is methyl > ethyl > isopropyl > tertiary butyl, but the results may be affected, as pointed out by the original authors, by crystal lattice forces and the formation of several species of complexes (*10*). Steric factors should be of less importance here than in the group V and VI compounds, and accordingly the data support the view of hyperconjugation in these compounds.



$$CH_3-\underset{\circ\circ}{\overset{+}{\overset{\circ\circ}{Cl}}}-\bar{Ga}Cl_3 \longleftrightarrow H-\underset{H}{\overset{H^+}{C}}=\underset{\circ\circ}{\overset{\circ\circ}{Cl}}-\bar{Ga}Cl_3$$

3 equivalent forms

Thus far we have considered only *hyperconjugation* with empty *d*-orbitals, but other types of conjugations may also be important. Thus the basic properties of the phosphorus trihalides (*11*) may be explained by π-bonding involving the halogen attached to the phosphorus.



$$Br_3\bar{B}-\overset{+}{P}Cl_3 \longleftrightarrow Br_3\bar{B}-P{\overset{\textstyle /\!\!/\overset{+}{Cl}}{\underset{\textstyle \setminus Cl}{-Cl}}}$$

3 equivalent forms

Evidence supporting the existence of π-bonding in four coordinated phosphorus compounds has recently been published (*12*). The observation was made that π-bonding is of greater importance in four-coordinated phosphorus than in compounds of other coordination number. This is undoubtedly due to the formal positive charge that would be placed on phosphorus if only σ-bonds were present in the four-coordinated state. Since a formal positive charge would be present on the central atom

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whenever the compounds of the group V, VI and VII elements act as Lewis bases, π-bonding should be an important factor in the base strength of these compounds.

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References and Notes

1. There is a slight irregularity in the amine family, the tertiary amines being less basic than the secondary amines. This anomaly has been explained by H. C. Brown, H. Bartholomay, and M. D. Taylor in terms of B-strain [*J. Am. Chem. Soc.* 66, 435 (1944)] and by R. G. Pearson and F. V. Williams in terms of solvation effects [*J. Am. Chem. Soc.* 76, 258 (1954)].
2. H. C. Brown *et al.,* Abstr. of 121st meeting, American Chemical Society, p. 9N; R. E. Weston, Jr., and J. Bigeleisen, *J. Am. Chem. Soc.* 76, 3074 (1954).
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5. W. A. G. Graham and F. G. A. Stone, *Chemistry and Industry* 1956, 319 (1956); *J. Inorg. Nuclear Chem.* 3, 164 (1956).
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12 December 1956

Distribution of Calcium in Adult Drosophila melanogaster

It has been shown by Levine (*1*) that the amount of crossing over observed in females of *Drosophila melanogaster* can be decreased by feeding adults on medium containing increased amounts of calcium. Similar effects are produced if the females are desiccated during pupal life. On the other hand, crossing over is increased if the females are fed during larval life on a medium containing the chelating agent, ethylenediaminetetraacetic acid. To explain these results, Levine postulated that calcium normally plays a role in the nuclei of *D. melanogaster* and that this role is to "stabilize" the chromosomes. Therefore, if the cellular calcium concentration is increased by feeding the fly extra calcium or by decreasing the water content of the cells by desiccation, the chromosomes are "stabilized" and show less crossing over. Conversely, if the calcium content is decreased by administering a chelating agent, then the chromosomes become "unstable" and show increased amounts of crossing over.

However, it is hard to reconcile this theory with certain information that is available concerning the calcium requirements of *D. melanogaster.* It is known, for example, that if calcium is required by *D. melanogaster* at all, it is necessary only in minute quantities (*2*). Furthermore, Yasuzumi and Sawada (*3*) have shown that, whereas calcium is present in the cytoplasm of the larval salivary gland cells of *D. virilis,* it is apparently absent in the chromosomes, and Poulson and Bowen (*4*), utilizing radiocalcium, found no evidence for nuclear localization of calcium in larvae of *D. repleta.* In addition, Poulson and Bowen state that "the rapid transfer of the element to storage areas of the malpighian tubules contraindicates the existence of any major calcium component in tissues generally."

The results of our autoradiographic studies (*5*) of Ca^{45}-localization in adult *D. melanogaster* are in complete agreement with the statement of Poulson and Bowen. Flies of the Oregon-R strain were fed during the larval and adult stages on *Saccharomyces cerevisiae* homogeneously labeled with Ca^{45}. Autoradiograms of adults showed Ca^{45} to be homogeneously distributed in the blood and tissue fluids and concentrated only in the terminal portions of the anterior malpighian tubules. Developed grains were equally abundant whether above the nuclei or the cytoplasm of the cells making up various tissues. There was no concentration of calcium in oocyte nuclei or sperm heads. The calcium content of the adults was 165 ppm. Males and females did not differ significantly with respect to the distribution of calcium. The distribution of calcium from yeast ingested during adult and larval stages was as follows: head, 0.131; thorax, 0.141; legs, 0.051; wings, 0.024; gut, 0.084; reproductive system, 0.037; malpighian tubules, 0.109; abdominal residue, 0.066; and liquid residue (mainly hemolymph), 0.357 (for adult flies 0 to 1 day old).

We conclude (i) that *Drosophila melanogaster* requires at most trace amounts of calcium, (ii) that the majority of the calcium taken in is rapidly transferred to and stored in the excretory organ of the insect, and (iii) that calcium is not required as a component of chromosomes in concentrations higher than those found in the cytoplasm and body fluids.

It follows that, if calcium plays a role in "stabilizing" the chromosomes of *D. melanogaster,* then extremely small amounts are required. It is difficult to see under these conditions why adding more calcium to the standard medium should have any effect. It also seems unlikely that ethylenediaminetetraacetic acid can reduce the available calcium in the standard medium below the traces in which it is required.

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References and Notes

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5. This work was supported by the U.S. Atomic Energy Commission.

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Purification of Poliovirus with Fluorocarbon

When we were searching for a procedure for removing protein from crude viral suspensions, the report of Gessler *et al.* (*1*) came to our attention. Gessler *et al.* have described a procedure for the purification of vaccinia and Rous sarcoma virus in which infected tissues are homogenized in a high speed blender with a fluorocarbon mixture. On separation of the two phases, it was found that nonviral protein was removed from the aqueous layer, whereas the virus remained in it. This communication (*2*) reports results following the application of a similar procedure to the purification of poliomyelitis virus, type II, strain MEF-1, that was grown in a culture of HeLa cells.

The medium used for propagation of

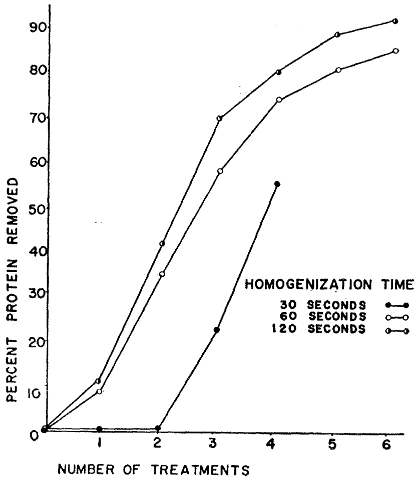

Fig. 1. Protein removal by fluorocarbon treatment.