and crystal systems of the principal naturally occurring higher arsenides of these metals and a revised classification based in part on the results of these experiments in synthesis are shown below.

| *Previous Classification* | *Composition* |
|---|---|
| Orthorhombic Arsenides | |
| Safflorite | $CoAs_2$ |
| Rammelsbergite | $NiAs_2$ |
| Pararammelsbergite | $NiAs_2$ |
| Löllingite | $FeAs_2$ |
| Isometric Arsenides | |
| Diarsenides | |
| Smaltite | $CoAs_2$ |
| Chloanthite | $NiAs_2$ |
| Arsenoferrite | $FeAs_2$ |
| Triarsenides | |
| Skutterudite | $CoAs_3$ |
| Nickel-skutterudite | $NiAs_3$ |
| Iron-skutterudite | $FeAs_3$ |

| *Revised Classification* | *Composition* |
|---|---|
| Orthorhombic Arsenides | |
| *Cobalt-löllingite (Safflorite) | $(CoFe)As_2$ |
| Rammelsbergite | $NiAs_2$ |
| Pararammelsbergite | $NiAs_2$ |
| Löllingite | $FeAs_2$ |
| Isometric Arsenides | |
| Diarsenides (Discredited) | |
| Smaltite (Identical with skutterudite) | |
| Chloanthite (Identical with nickel-skutterudite) | |
| Arsenoferrite (Identical with iron-skutterudite) | |
| Triarsenides | |
| Skutterudite | $CoAs_3$ |
| *Nickel-skutterudite | $(CoNi)As_3$ |
| *Iron-skutterudite | $(CoFe)As_3$ |

* Indicates pure mono-metallic end member neither satisfactorily established as occurring in nature nor produced synthetically.

For the first time the existence of the orthorhombic minerals rammelsbergite, pararammelsbergite and löllingite as arsenides of the pure metals has been confirmed by the results of synthesis and x-ray studies. Consideration of the data for both natural and synthetic "safflorite" provides no evidence of the existence of a pure orthorhombic cobalt diarsenide and suggests that this mineral might be considered a cobaltiferous löllingite rather than an independent species.

In view of the previous discussion it would seem that the names smaltite, chloanthite and arsenoferrite, which have long been applied to minerals accepted as isometric diarsenides of the elements cobalt, nickel and iron, respectively, no longer serve any useful purpose. In fact, their retention in the literature tends to confuse our view of the relationships of the isometric arsenides of these metals, all of which are apparently structurally triarsenides whether or not they can be shown to possess the exact chemical composition demanded by the R: $As_3$ ratio.

Furthermore, it would seem that the name skutterudite should be applied to the entire group of isometric arsenides of cobalt, nickel and iron, since the cobalt triarsenide is the most firmly established of all the isometric arsenides of these metals. In the course of the present investigation it has been synthesized and the identity of the synthetic product and the natural mineral skutterudite established for the first time. The same investigation has established the existence of a three-fold isomorphous series of isometric triarsenides ($CoAs_3$-$NiAs_3$-$FeAs_3$) in which the elements cobalt, nickel and iron substitute for each other in various proportions. The nickel and iron end members of this series have not been synthesized; neither has their existence in nature been satisfactorily established. The precise limits of substitution of the three metals in the series are yet to be determined. Inasmuch as pure nickel and pure iron end members are missing there is little justification for assigning them special names. It would seem preferable to apply the appropriate prefix, as has already long been done in the case of nickel skutterudite for the high nickel, high iron or high nickel and iron varieties.

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## EFFECT OF MUCIN ON INFLUENZA VIRUS INFECTION IN HAMSTERS[1]

IN a study of factors which decrease the resistance of experimental animals to virus respiratory infections, the effect of the intratracheal inoculation of hamsters (*Cricetus auratus*) with influenza A virus in mucin has been determined.

The hamster was selected as the test animal because it appeared, from Taylor's work,[2] to have a limited susceptibility to this virus, as evidenced by failure to develop gross lesions. Mucin was used, since it has been shown to lower resistance to bacterial infections;[3] further, the possible role of mucous secretions in decreasing resistance to infections of the respiratory tract in general has been the subject of several papers by our group.[4,5,6]

### METHOD

The PR-8 strain of influenza A virus[7] was main-

[1] This work was aided by a grant from The Kresge Foundation.

[2] R. M. Taylor, *Proc. Soc. Exp. Biol. and Med.*, 43: 541, 1940.

[3] W. J. Nungester, A. A. Wolf and L. F. Jourdonais, *Proc. Soc. Exp. Biol. and Med.*, 30: 120, 1932.

[4] W. J. Nungester and L. F. Jourdonais, *Jour. Infect. Dis.*, 59: 258, 1936.

[5] W. J. Nungester and R. G. Klepser, *Jour. Infect. Dis.*, 63: 94, 1938.

[6] W. J. Nungester, R. G. Klepser and A. H. Kempf, *Jour. Infect. Dis.*, in press.

[7] Obtained through the courtesy of Dr. Thomas Francis, Jr.

tained by mouse passage, and 0.1 ml of a 1 per cent. suspension of infected mouse lung in mucin or physiological saline was the inoculum used. The hamsters were two to six months old. Sterile 5 per cent. gastric mucin suspensions were prepared according to a technique previously described,[4] and also by a method to be published in a subsequent paper. Both preparations were satisfactory.

The hamsters were anesthetized by the intraperitoneal injection of Nembutal. Since intratracheal inoculations through the mouth with the aid of a catheter were not satisfactory, the trachea was exposed and 0.1 ml of the virus suspension in mucin, or physiological saline, was injected with a 25-gauge needle. The skin was then sutured. In one experiment, six hamsters were injected with 0.1 ml of virus previously neutralized with inactivated rabbit influenza A antiserum.

The animals were sacrificed six to eight days after inoculation, the lungs were removed, and gross pathological changes observed. The data from a few animals with concomitant bacterial infections, as determined by positive cultures on blood agar, were not included.

### RESULTS

The results summarized in Table 1 indicate that when influenza A virus was suspended in sterile mucin, and injected intratracheally in hamsters, gross lung lesions developed which were similar to those seen in the lungs of mice infected with this strain of influenza virus. Since the incidence and extent of the lesions were markedly reduced, using an inoculum of mucin and influenza A virus neutralized with specific antiserum, it may be concluded that these results were not due to other viruses or bacteria present as contaminants. It should be noted that evidence of consolidation, however slight, is recorded in the table as a gross lesion. This may direct some unwarranted attention to the occurrence of lesions in animals inoculated with mucin alone, or with neutralized virus and mucin, since the lesions in these two groups of animals were small.

TABLE 1

THE USE OF MUCIN IN THE PRODUCTION OF INFLUENZA VIRUS PNEUMONIA IN HAMSTERS

| Inoculum | Number of hamsters | Per cent. with gross lesions | Average number of lobes involved | Extent of lesion |
|---|---|---|---|---|
| Virus in saline .. | 11 | 9 | 3 | + |
| Virus in mucin .. | 31 | 71 | 4 | +++ |
| Mucin ..... | 20 | 25 | 1 | + |
| Neutralized virus in mucin ..... | 6 | 33 | 2 | + to ++ |

(+) Smallest visible lesion to 25 per cent. involvement, (++) 25 to 50 per cent. involvement, (+++) 50 to 75 per cent. involvement, of each infected lobe.

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# SCIENTIFIC APPARATUS AND LABORATORY METHODS

## THE PREPARATION OF SODIUM PYRUVATE

PYRUVIC acid, because of its important position in the intermediary metabolism of proteins and carbohydrates, is being used with increasing frequency in physiologic experimentation, including studies on tumor metabolism. The stable sodium salt is the most desirable form for handling this compound. However, the usual method of preparation of sodium pyruvate,[1] involving a very sensitive neutralization of small amounts of freshly distilled aqueous pyruvic acid with dilute alkali, is tedious and bothersome. The yield is often poor and contaminated with brown resinous condensation products.

If the neutralization of pyruvic acid is carried out in alcohol, sodium pyruvate, because of its insolubility, will be removed from the reaction as soon as formed. The following simple method, which is based on this fact, permits rapid preparation of any desired amount of the salt. Dissolve 10 ml (12.7 gm) of pyruvic acid (Eastman-498) in 100 ml of alcohol. Redistillation is unnecessary. (A sample which had stood in the laboratory for some weeks and was quite yellow yielded sodium pyruvate which appeared as good as the sample whose analysis is reported below.)

Sodium pyruvate: $CH_3 \cdot CO \cdot COONa$

Calculated— C–32.71 per cent.; H–2.75 per cent.; Na–20.90 per cent.

Found— C– 32.63 per cent.; H– 2.96 per cent.; Na– 21.15 per cent.
C– 32.58 per cent.; H– 2.71 per cent.; Na– 20.83 per cent.

The acid is neutralized with alcoholic alkali made by diluting 10 ml of saturated sodium hydroxide with 100 ml of alcohol. The neutralization may be carried out at room temperature and does not have to be exact, for excess alkali is without immediate effect. (A preparation which had been considerably over-titrated showed only traces of yellow condensation products after standing 24 hours.) The sodium pyruvate, which precipitates as a white amorphous powder, is

[1] E. M. Case, *Biochem. Jour.*, 26, 753: 1932.