Comment. It is fully realized that hardly any of the *Mycoplasma* species hitherto described do in fact strictly meet the requirements that are formulated in paragraph 6, *a*. It is appreciated, moreover, that self-evident though these requirements are in principle, it will prove difficult or even impossible for any single worker or group of workers to satisfy the demands. However, it is hoped that the gradual creation of a network of reference laboratories may help to ameliorate the situation in this respect and steps are being taken toward this end.

At any rate, rather than compromising too much with the above requirements, it would be wise policy to restrain one's taxonomic efforts and to publish any new isolates merely under their catalog designations, thus providing a useful and necessary means of reference until it is possible to provide a reasonably adequate description.

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13 March 1967

Sexual Reproduction in Histoplasma capsulatum

Recent successes (*1*) in stimulating sexual reproduction among the dermatophytes and related fungi inspired a search for the perfect state of fungi that cause systemic disease in man. One of the organisms under study was *Histoplasma capsulatum*, the etiologic agent of histoplasmosis, a pulmonary disease of global importance. Twenty-nine isolates of this mold, recovered from soil, bats, or humans, were grown singly or in combination on small pieces of sterilized chicken feathers or horse hairs placed on plates of moistened, sterilized soil.

Cleistothecia filled with asci and ascospores were formed by two of the isolates. With the aid of a micromanipulator, single ascospore cultures were obtained, and the organism was found to be homothallic.

The two cultures that developed the cleistothecia (H-2 and H-8) had been isolated from soil collected under a starling (*Sturnus vulgaris*) roost in Illinois (H-2) and from a case of histoplasmosis (H-8) in Puerto Rico.

The morphological characteristics of the cleistothecia and their asci were typical of the genus *Gymnoascus* of the family Gymnoascaceae. The perfect state of *Histoplasma capsulatum* is being studied.

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6 February 1967

Medial Superior Olive and Sound Localization

Harrison and Irving (*1*) show that some animals which are capable of localizing a sound source do not possess a medial superior olive. On this basis, the authors rule out the idea that the medial superior olive is essential for sound localization. However, the electrophysiological data which they cite (*2*), together with some recent behavioral data not available to them (*3*), suggest an alternative interpretation of the presence or absence of the medial superior olive in specific mammals.

In order to understand the contribution of the medial superior olive to sound localization, it is necessary to distinguish between the two potential cues in the stimulation reaching the ears, both of which vary with the azimuth of the source of a brief sound (*4*). The first of these potential cues is the difference in the time of arrival of the wave front at the two ears. This time difference, Δt, depends directly on the distance between the ears and inversely with the speed of sound in the conducting medium. Animals with small heads and aquatic animals with even moderately large heads are virtually deprived of this potential cue since the interaural distance is small or the speed of sound is too great.

The second potential cue for the localization of the source of a brief sound is the differences in the frequency spectrum of the stimulation reaching the two ears (*5*). The spectrum difference, $\Delta(fi)$, depends on the effectiveness of the sound shadow produced by the head and pinna. No animal is completely deprived of this potential cue, but since the effectiveness of the sound shadow decreases with a decrease in the proportion of high frequencies in the stimulation, animals (such as man) which are relatively insensitive to high frequencies are not exposed to a wide range in $\Delta(fi)$. Thus Δt is the more dramatic cue for azimuth in animals with wide-set ears while $\Delta(fi)$ is the more dramatic cue in animals with close-set ears, an aquatic habitat, or sensitivity to high frequencies.

The analysis of the Δt cue and the analysis of the $\Delta(fi)$ cue are accomplished by different structures in the auditory system. We have isolated Δt and $\Delta(fi)$ by delivering clicks through headphones worn by experimental animals (*3*). We observed that, first, surgical transection of the afferent tracts to the superior olive permanently abolishes Δt discrimination throughout the range which occurs in natural sound localization. Second, transection of lemniscal pathways from hindbrain to auditory cortex also abolishes Δt discrimination. Third, the same lesions which abolish Δt discrimination have little effect either on tasks requiring discriminations within the generic class $\Delta(fi)$ or on sound localization itself (*6*).

The first result, together with electrophysiological data showing that Δt analysis takes place in the medial superior olive but not in the lateral superior olive, suggests that the role of the medial superior olive in sound localization is the analysis of Δt. The second result shows that the product of the analysis in the medial superior olive must be available to the forebrain in order for the animal to discriminate Δt. The third result shows that an animal deprived of Δt analysis is not necessarily incapable of sound localization because $\Delta(fi)$ analysis is still available.

If we assume, as do Harrison and Irving, that the medial superior olive is homologous in all mammals and, further, that in the animals where it is present it is also similar in function, we conclude that animals without a medial superior olive may be insensitive to Δt and yet still capable of sound localization on the basis of $\Delta(fi)$.

Finally, we are persuaded that the correlation between the size of the abducens nucleus and the size of the medial superior olive discovered by Harrison and Irving can hardly be a matter of chance (*7*) and, further, that the authors are probably correct in concluding that the visual system makes use of the Δt analysis provided by the medial superior olive. The size of the medial superior olive in auditory systems sensitive to Δt may indeed depend on its contribution to reflexive eye, ear, and head movements as Harrison and Irving argue, but this function is in addition to, not instead of, its contribution to the higher order instrumental activities generated by the forebrain.

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4. It is essential to restrict the discussion to brief sounds since any other kind can be easily localized by head movements and require no special analytic apparatus.
5. The second cue is usually called an intensity difference. This term was derived from research on localization of pure tones and, for brief sounds, is a bit misleading. Frequency spectrum difference is a more comprehensive term which includes intensity differences as special cases.
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7. After reading Harrison and Irving's report, we counted the cells in the homologous nuclei of tree shrew (*Tupaia glis*), which has a retina containing only cones, and bushbaby (*Galago senegalensis*), which has a retina containing only rods. Although our cell counts place these animals intermediate to the two regression lines reported by Harrison and Irving, neither is so far off as to deny the general relation.
8. Supported by NIH grants NB-5251 and M-4849.

13 January 1967

Our work (*1*) on the nuclei of the superior olivary complex was essentially an anatomical study of the size of the medial superior olivary nucleus and of the relation between the size of the medial superior olivary nucleus and the size of the 6th nucleus. Since the medial superior olivary nucleus is absent in some animals, mammals can be divided into two groups—those with and those without the medial superior olive. That is, two types of auditory systems can be distinguished. These anatomical data tell nothing about the functional (behavioral and physiological) properties of these structures, except that in those animals in which the medial superior olive is missing (bats, for example) localization and other auditory behavior must depend upon other structures. Masterton and Diamond point out that auditory localization may be based on time, Δt, and intensity, $\Delta(fi)$, differences of the stimulus at the two ears, and they suggest that one of these, the Δt discrimination, depends upon the medial superior olivary nucleus.

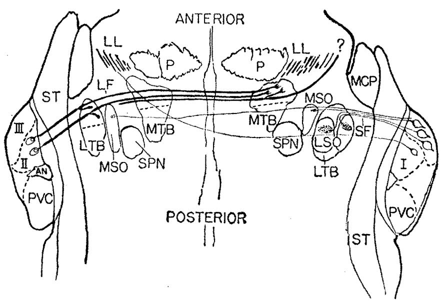

Fig. 1. Schematic horizontal section through the acoustic system of the rat. The principal ascending nerve fibers which run in the ventral acoustic stria are shown. *AN*, Acoustic nerve; *LF*, large fibers of trapezoid body; *LL*, lateral lemniscus; *LSO*, lateral superior olivary nucleus; *LTB*, lateral nucleus of trapezoid body; *MCP*, middle cerebellar peduncle; *MSO*, medial superior olivary nucleus; *MTB*, medial nucleus of trapezoid body; *P*, pyramidal tract; *PVC*, posterior ventral cochlear nucleus; *SF*, small fibers of the trapezoid body; *SPN*, superior paraolivary nucleus; *ST*, spinal trigeminal tract; *I*, *II*, *III*, regions of the cochlear nucleus.

One way to investigate the role of the various nuclei of the superior olivary complex in behavior is to conduct the type of experiments reported by Masterton and Diamond. The problem of determining the role of these nuclei in behavior by the lesion method, however, is exceedingly complex because of the structural arrangements of the nerve fiber bundles and the nuclei of the ventral acoustic system of the medulla (*2*). Figure 1 shows some of the principal ascending bundles of axons which run in the ventral acoustic stria. Sectioning the afferent nerve fibers to the superior olivary complex will interrupt a number of ipsilateral and contralateral pathways (including that to the medial superior olive). Therefore, structural interpretations of the behavioral effects of such lesions are hazardous. Sectioning the afferent tracts to the superior olivary complex abolishes Δt discrimination, but because of the foregoing considerations many interpretations of such lesions are possible. The interpretation by Masterton and Diamond may be correct, but it could just as well be incorrect.

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14 February 1967