any insect he happens to have obtained. In preparing this key, the authors have taken advantage of all previous work which appeared serviceable, added to their own extensive knowledge of a number of groups, so the result is probably not far from the best attainable in the present state of our knowledge. The book will be invaluable to all students of entomology, and will be in constant use in every entomological laboratory. The details of insect classification are not so well established that it is possible to present a system which will be universally approved. In the present case we recognize a number of improvements over arrangements previously current, but we must protest against the uncritical adoption of the system of Handlirsch. It is actually proposed to recognize five classes of insects, the additional four being made out of the Aptera, one of them containing the recently discovered Protura. Then, again, the old order Orthoptera is divided into a long series of orders, placed in two subclasses. The reviewer has not critically reconsidered the whole subject to determine exactly what support may be found for all these changes, but neither has any one else in this country, so far as we know, for it would involve many months or years of intensive labor, with access to very large collections. The reviewer has however had much occasion to use Handlirsch's great work "Die fossilen Insekten," in which the new classification appears, and has come to a clear estimate of its merits and faults. It is a wonderful compilation, showing enormous industry and great ability, and will always rank as a classic in the literature of entomology; but in detail, and especially in its innovations, it is not to be trusted, the taxonomic arrangements set forth with so much assurance being often based on very inadequate grounds or imperfect knowledge. It may well be that this author has been taken more seriously than he himself intended. A new classification, even if faulty, is of value if it stimulates thought and is received in a critical though friendly spirit; to adopt it *en bloc* without criticism is in a sense to do an injustice to the eminent author.

Only frequent use will show how serviceable the key is in all its details. Undoubtedly many little changes will be required in the next edition. As the authors observe, the families are not of equal rank, and it seems impracticable to make them so. All the scale insects and mealy-bugs are still Coccidæ, all the ants are called Formicidæ, while the bees are divided into twelve families.

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ON THE ACOUSTICS OF THE CHAPEL OF ADELBERT COLLEGE

IN SCIENCE of November 14, 1913, was published a short account of experiments made to determine the effect of a sounding board on the acoustic qualities of the chapel of Adelbert College. The sounding board, constructed at the suggestion of the architect of the building, and in accordance with his specifications, was of the canopy type, about six feet in diameter, and suspended about two feet above the head of the speaker. An investigation showed, as was not unexpected, that the sounding board was without noticeable effect, and it became necessary to try other remedies.

A sufficiently detailed description of the interior of the chapel is given in the previous article, and need not be repeated. The ceiling of the building is of wood, the walls are in part of stone, and in part of plaster laid directly upon the stone without lath or furring.

There was no evidence, as was before stated, of special or local echoes. The difficulty was plainly one of excessive reverberation, due to the insufficient absorbing power of the walls and ceiling. It was evident that the only effective remedy was to cover a portion of the walls with highly absorbent material, after the manner devised by Professor Sabine, of Harvard University. The generosity of the donors of the chapel provided the necessary means; the work was intrusted to an "acoustic engineer," a former student of Professor Sabine's, and Mr. Sabine himself was good enough to aid with counsel and suggestion.

Calculation showed that a reasonably effective treatment might be obtained by covering the ceiling and the upper part of the walls

down to the springing of the window arches with a specially prepared felt.

The felt as actually applied was two inches thick on the ceiling, one inch thick on the side walls. The work was carried out with admirable efficiency and carefulness. The appearance of the chapel was practically unchanged, so that no one, unaware of the treatment, would have guessed that any application of the kind had been made.

Experiments extending over one college year were made to test the effectiveness of the arrangement.

A college chapel service, where attendance is required, affords a unique opportunity for a study of this kind. Five regular services weekly are held in the Adelbert College chapel. One of these is a musical service; the other four generally include a short address on some practical or ethical subject. The services are conducted by a number of clergymen from the city, each of whom officiates in general all the four days in a given week. It is possible, therefore, for an observer to listen to the same speaker for four successive days. The audience is practically the same each day, and the general conditions are nearly constant, so that the observations made on successive days are comparable to a satisfactory degree.

The experiments consisted simply in listening to a speaker on successive days, from different parts of the auditorium, and noting down in each case the percentage of the words spoken which were clearly understood. Effort was made to consider only words which were definitely heard, excluding as far as might be those gained by association from the context. Previous experiments, in connection with the sounding-board, had given some facility in this kind of work. Of course, only a rough approximation is possible, yet the margin of error is perhaps less than would be at first supposed. The attention is fixed, not on the number of words understood, but on the number missed. It is easy to distinguish approximately between the loss of one word in five, one in ten, one in twenty; these correspond to an audibility of 80, 90 and 95 per cent., respectively. 95 per cent. means excellent hearing, 90 per cent. is fair, but if the number of words heard is only 80 per cent. of the whole, the hearing is positively poor, and below this runs rapidly into unintelligibility. Perfectly satisfactory hearing, clear and sharp, without effort or close attention, is rated at 100 per cent.

Four seats were chosen as places of observation, one in the front row of the gallery at the back of the chapel, perhaps ninety-five feet from the pulpit where the speaker stood, three on the floor, seat AA, immediately under the front edge of the gallery, about ninety feet from the speaker, seats V and Q, respectively seventy-five and fifty-five feet from the speaker. The observer sat on successive days in each of these seats in rotation, making notes as suggested above.

The chapel was treated with the absorbent felt during the summer vacation of 1914. The experiments began in February, 1914, while the chapel was in its original condition, while the second set, after the treatment of the walls, extended from the latter part of September, 1914, to the end of February, 1915, the whole including two college semesters.

The relative number of words heard in the case of each speaker having been evaluated as closely as possible, the results were averaged for each position of the hearer. For example, in the seat AA, ninety feet from the speaker, 25 experiments were made during the first semester, varying in intelligibility from 10 per cent. to 95 per cent. The average of all the speakers was 71 per cent. This means that on the average more than one word in four was missed by the hearer. In almost every case the necessary attention was recorded as "careful" or "strained." Listening was wearisome, and it was often impossible to follow intelligently the purport of the address.

In the second semester, sitting in the same position, 28 speakers were heard. The average audibility was 91 per cent. The attention given was recorded as "easy" in about half the cases, as "careful" in the others. In no case was a tense or strained attention needful.

The improvement in hearing was greatest, of course, in the case of those who were heard with difficulty, though in all cases the gain was

marked. One speaker in particular, as the result of several hearings, in the first half-year was rated at 10 per cent., in the second at 76 per cent.

Of the different speakers, six were heard in both of the semesters, and are thus more directly comparable than the others. Their average for the first semester was 64 per cent., for the second, 92 per cent., that is, while during the first semester more than one word out of every three was unintelligible, only about one in twelve was unheard in the second.

The effect was even more striking in seat V. Before the treatment of the chapel the average audibility was 71 per cent., exactly the same as at the greater distance, showing that the advantage gained by a somewhat nearer approach to the speaker was completely nullified by the disturbances from reverberation. The attention, as in the seat AA, was careful or strained. After the treatment the average audibility rose to nearly 96 per cent., nearly perfect hearing, and the attention in most cases was noted as easy.

In seat Q, about fifty-five feet from the speaker, the audibility rose from an average of 95 per cent. in the first semester to 100 per cent. in each separate case in the second.

The results are summarized below for more easy comparison.

AVERAGE OF ALL SPEAKERS

Seat	First Semester, Per Cent.	Second Semester, Per Cent.
AA	71	91
V	71	96
Q	95	100

The seat in the gallery gave exactly similar results, but the number of experiments made in this seat was so small that the averages are not included in the table.

The condition of the auditorium at present is satisfactory. It is quite possible that a slight further reduction of reverberation might be made with advantage to the spoken word, but the effect of music, which forms an important part of the uses of the building, would be correspondingly injured.

It may be worth while further to remark that the calculations as to the effect of reverberation could have been as well made, plan and materials being given, before the erection of the building as afterward. It is a pity that architects still construct buildings of this kind without giving careful attention to their expected uses, trusting to good fortune for acoustic fitness which might easily and certainly be insured in advance.

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SPECIAL ARTICLES

TWO COLOR MUTATIONS OF RATS WHICH SHOW PARTIAL COUPLING

IN the *American Naturalist* for February, 1914, Castle described two yellow-coated varieties of the Norway rat (*Mus norvegicus*) which had recently been discovered in England, and both of which had been found to behave as Mendelian recessive characters in heredity. One of these was called "pink-eyed yellow," the other "black-eyed yellow." A more appropriate name for the latter would be "red-eyed yellow" (which we shall hereafter use), since the eyes in this variety are not as dark as in wild gray or tame black rats, but the red blood of the eye shows through, particularly when the animal is young, giving the eye in a favorable light a reddish tinge.

Upon crossing the two yellow varieties with each other, we found them to be complementary. The F_1 young obtained were none of them yellow, but were all either gray or black coated; yet it should be noted that they were in no case as dark as ordinary gray or black rats. Nevertheless F_2 young with coats of normal intensity were later obtained, so that the paleness of the F_1 young was evidently due rather to their being heterozygous for the two complementary factors, than to any failure of one variation completely to supply what was lacking in the other.

Each of the yellow varieties was also found to be different in nature from ordinary albinism, as seen in white rats, since when it was crossed with albinos it produced only fully