United States, but especially common in the west and southwest, in the more arid parts of the country, where water stands for but a small part of the year and where the lymnæas, and other mollusks must be able to withstand the period of drouth by hibernating in cracks in the bottom of the pond or stream. Such species as *Galba caperata* (Say), *G. cubensis* (Pfr.), and *G. bulimoides* and its varieties are typical of these habitats. *Galba palustris* and some other species normally living in marshes may at times be compelled to adopt this hibernating type of habitat during unusual periods of drought.

The writer has not found lymnæas as a rule inhabiting moss, although the little amphibious species (*parva, dalli,* etc.) may do so in some places and have, indeed, been collected from such a habitat. All lymnæas as well as other fresh water mollusks, whether in lake or marsh habitats, prefer a location where there is a quantity of vegetation and where there is an abundance of filamentous algæ (*Cladophora, Œdogonium,* etc.) upon which they largely feed, in some cases to such an extent as to give a green color to the shell. The relation of algæ to molluscan and other life has recently been rather fully stated by the writer.[7]

It is interesting to note that fresh-water mollusks, the lymnæas in particular, respond quickly to changes in environment, a species characteristic of a marsh adapting itself to a rough lake shore habitat if compelled to make the change. Thus typical *stagnalis* is characteristic of quiet, pond-like bodies of water, while the variety *lillianæ* lives on a shore exposed to the full force of the waves. The change in habitat has resulted in a larger aperture and foot in *lillianæ* the better to resist the moving power of the waves. In Oneida Lake, a large colony of *Galba palustris* was forced by a change in the environment, caused by the barge canal construction, to change from a shallow swampy habitat to that of an open rocky shore exposed to violent wave action. The effect of this change has been to produce a shell with a wide, flaring aperture and a larger foot area, a direct response to the environment which demands a larger foot area for resisting the waves.[8] The lymnæas are not, as generally supposed, mollusks chiefly of ponds and ditches, as might be thought from reading the paper in SCIENCE, but also of the larger inland lakes, in fact a greater variety is found in the lakes than in any other kind of habitat.

The fossil lymnæas, as well as other fresh-water fossil groups, are in need of careful revision in the light of modern work on the existing species. As the shell in a measure reflects the internal structure, this revision ought not to be difficult with ample material of fairly well-preserved specimens. The twenty-five or more species described appear to represent the larger groups recognized among the recent forms. Several of these species, as mentioned by Hannibal, are problematic and may belong to other groups, but more perfect material is needed for this purpose. Some confusion of species has occurred in figuring and describing a few of these lymnæas, attention to which has already been directed by the writer.[9]

FRANK COLLINS BAKER
UNIVERSITY OF ILLINOIS

[7] Tech. Pub., No. 9, N. Y. State College of Forestry, Syracuse University, 1918.

[8] Baker, Tech. Pub. No. 9, N. Y. State College of Forestry, p. 180.

[9] "Mon. Lymn. N. Am.," pp. 89, 95, 96.

SPECIAL ARTICLES

SOUND AND FLASH RANGING[1]

THE location, by means of sound, of active enemy batteries and the direction of the fire of the friendly artillery on these and other enemy objectives is new; has been successfully practised by the Allies and has been clumsily practised by the Germans. The location and ranging by visual observation (flash ranging) is an outgrowth of standard artillery methods and differs from these chiefly in the extent of front covered by a single group of observers and by the adoption of certain electrical devices and

[1] Abstract of paper presented before the American Philosophical Society, April 26, 1919.

methods of observation designed to avoid confusion in operation on a very active front. The Germans had an extremely efficient flash ranging service, many of the good features of which were copied by the Allies as they became known through captured documents. The flash ranging reported not only the positions and activity of hostile batteries, but also the exact locations of other enemy objectives such as traffic on roads, troop movements, position of observation balloons, etc. Being provided with high-power telescopes, and since observation was obtained from stations on a wide base (from five to eight miles) the flash ranging sections were particularly well suited for observation and ranging in the enemy back areas, and these sections rendered invaluable services both to the artillery and to the army intelligence.

A battalion of five companies (74th Engineers) furnished the ranging troops for an American army. A sound ranging section was in the field with the first American division to enter the line (March, 1918) and on the signing of the armistice the entire front of the second American army was covered with both flash and sound ranging sections and a portion of that of the first American army was covered by flash ranging, although the ranging battalion allotted to this army had not yet arrived in France. The ranging service was thus a "going concern" from the very first and was not one of the many which could have delivered results had the war but lasted a little longer.

A flash ranging section consisted of about one hundred men commanded by a lieutenant who was assisted by three other officers and by an exceptionally high grade of non-commissioned officers and men, all of whom had been given a month's intensive training in France. The instruments and methods employed were those suited for accurate survey and present no special features of interest.

A sound ranging section was similar in organization to the flash section except that there were fewer enlisted men (60–70) due to the fact that instruments took the place of living observers to a great extent. The "central" instrument recorded photographically the time of arrival of the sound of the enemy guns at a series of instruments at surveyed positions near the front line and covering a length of about five miles; this instrument delivered automatically developed and fixed photographic records in less than a minute after the sound of the enemy gun reached the front line and this record could be interpreted by the use of quick graphical methods so that the position of the enemy gun could be telephoned to the friendly artillery in about a minute more. The probable accuracy of the location could be given and also the caliber and target of the piece which had just fired. The service was not interfered with by rain or fog or darkness, though it was rendered less accurate by strong winds. Calculations were rendered difficult by great artillery activity though not impossible except under actual "barrage" conditions.

In ranging the friendly artillery on enemy objectives it was possible to range all the guns of the battery simultaneously, thus effecting considerable time saving over other methods of ranging. If the ranging was being done on an enemy battery which had just fired the accuracy attained was very great (less than twenty-five yards), because of the fact that in this case no wind or temperature corrections need be applied in the calculations.

After the American advances of September and November a careful survey was made of most of the enemy positions which had been located by either the sound or the flash ranging sections on a part of the American front; the result of this survey was that of the locations of the flash ranging about one third were accurate to within fifty yards, another third to within one hundred yards and the other third with errors of more than one hundred yards. In the first third were many extremely accurate locations of guns the positions of which were visible from two or more observation posts; in the last third were mostly locations of concealed heavy caliber distant guns generally more easily located by sound ranging, whose positions could only be inferred from smoke puffs by day or flares in the sky by night.

The survey showed that the estimates of accuracy made by the sound rangers in report-

ing a location had been very conservative; a location reported not accurate to within fifty yards was often accurate to within twenty-five yards. In general, the average of a half dozen locations of the same gun taken on different days under differing weather conditions was of a very high order of accuracy; often a matter of but five or ten yards.

In general a location either by sound or by flash which had been rated "fair" when reported to the artillery was found on survey to have been within the unavoidable errors in artillery fire.

An idea may be gained of the amount of artillery information supplied by the ranging sections from the following figures taken from the reports of the artillery information officer of one of the American corps. This officer had at the time the following sources of information: three American sound ranging sections, two American and three French flash ranging sections, aviation and observation balloons. During a period of three weeks of rapid advance when the sound sections were out of operation while moving for a considerable portion of the time 425 separate locations of enemy batteries were made. Of these the two American flash sections reported 64 per cent. the three French flash sections reported 16 per cent. and the three American sound sections reported 21 per cent. In a period of two weeks when the advance had been checked by the Germans the total number of locations were 392, and the percentages were: From the three American flash sections 38 per cent.; from the two French flash sections 8 per cent., and from the three American sound sections 56 per cent.

The following figures taken from another and very active sector are also instructive. For a period of three days preparation for an advance, the following locations were made: Sound, 22; flash, 22; balloons, 0; aviation, 0. For a period of sixteen days of rapid advance: Sound, 4; flash, 46; balloons, 30; aviation 77. For a period of four days of stabilization: Sound, 6; flash, 34; balloons, 13; aviation, 15. These figures are characteristic. During preparations for an advance, both the sound and flash sections are very useful and important sources of information. During rapid advance the sound ranging does not get into action as often or as soon as the flash. In this period the greater part of the information comes from the air observation.

Both sound and flash ranging have proved their value in the American Expeditionary Forces and are to be retained in the peace-time army; the sound because it is the one source of information when all others fail in foggy weather and because thus far no camouflage has been devised to prevent its working; the flash because of its relatively great mobility and consequent importance in open warfare.

AUGUSTUS TROWBRIDGE
PRINCETON UNIVERSITY

THE AMERICAN MATHEMATICAL SOCIETY

THE two hundred and third regular meeting of the society was held at Columbia University on Saturday, April 26, extending through the usual morning and afternoon sessions. This being the first eastern meeting since October, the attendance was large, including sixty-seven members, indicating, as it may be hoped, a revival of the conditions preceding the war.

President Morley occupied the chair, being relieved by Professor Kasner. The election of the following persons to membership in the society was announced: Mr. N. W. Akimoff, Philadelphia, Pa.; Dr. Tobias Dantzig, Columbia University; Mr. A. C. Maddox, Guthrie, Okla., High School; Mr. Montford Morrison, Chicago, Ill.; Professor Ganesh Prasad, Central Hindu College, Benares, India; Mr. F. M. Weida, State University of Iowa; Mr. C. L. E. Wolfe, University of California. Two applications for membership were received.

It was decided to hold the coming summer meeting of the society at the University of Michigan in the first week in September. Professors Beman, Bliss, Karpinski, Osgood and the secretary were appointed a committee on arrangements for this meeting. A committee was also provided to prepare nominations for officers to be elected at the annual meeting in December.

Professor E. W. Brown, L. E. Dickson and H. S. White were appointed as representatives of the society in the division of physical sciences of the national research council; and President R. S.