THE MUSICAL WINGS OF INSECTS.

BY S. FRANK AARON.

The songs of birds and the trills of the toad and tree-frog fraternity are about the only musical sounds in nature that are throat utterances or true songs. The great host of insect musicians are performers upon instruments; and though they play upon fiddles and castanets that are a part of themselves, the sounds they produce are truly instrumental. The tunes they play, often incorrectly called songs, have been largely studied and set down, but little else has been made known concerning the manner in which the sounds are produced.

The winged musicians are commonly of two kinds; those that use their wings as instruments, and those that do not. Of the latter we have the cicadas or harvest flies (incorrectly called locusts). These perform upon abdominal plates like castanets, the sound produced resembling the nature of its production. The true wing performers are the crickets and long-horned grasshoppers, or true locusts, of which the katydid is a notable and characteristic representative. These fellows—for it is always the males, the sports and lovers of the insect world—perform serenades by the hour, no doubt addressed to their "mistress' eyebrow," on what might be called living fiddles.

With sharp eyes and keen ears one may, with a little trouble, make observations upon these insects, many of which are diurnal; and if we penetrate the forests of grass and weeds and bushes from latter July until early October, moving always cautiously and remaining motionless for minutes at a time, we shall often be rewarded by a sight of the little fiddlers.

Many of the players are nocturnal; the cricket on the hearth, whose cheery notes go far to make him popular with the country folk; the little snowy tree cricket (*Oecanthus niveus*), whost strict observance of time gives the repetition of his little tune the regularity of heart pulsations, varied only with the temperature of the air; the denizens of the deep rocky crevices and caves; those that insist that "katy-did and didn't"—these we shall seek best with lantern held before us; and when thus armed, often they will come to seek us.

Most insects are devoid of hearing, and it is remarkable that stridulation occurs at all. The locusts and crickets possess acute hearing. Their courtship is carried on entirely through the medium of their serenades. The males remain in one spot playing upon their instruments. The females, undoubtedly attracted by these songs, seek the players here and there with untiring energy.

And most remarkable is the character of the sounds produced in relation to the instruments played upon. These instruments are apparently not resonant. Indeed, they seem much too flimsy to produce metallic and far-reaching sounds. Except that the sound-producing portion of the wings, though varied in construction, is quite unlike the musical instruments of man, there is a resemblance in the tightened parchment-like sounding-board and the manner in which the wings are scraped together that partakes somewhat of the nature of a stringed instrument.

With the crickets proper the wings are raised almost or quite vertically while stridulating. With the locusts the sound-producing organs are elevated, so as to permit a scraping motion.

The musical organs are always attached to the fore wings. The hind wings are only used for flying. The fore wings of the cricket are for the most part taken up by the sound-producing, tightly-stretched portion. This part is strongly, but openly veined, and the toothed vein or bow extends entirely across this horizontal portion near its base. The roughened edge, where the toothed bow scrapes, is upon the inner margin. The right and left fore wings are precisely alike, so that either may be used for the bow or the fiddle.

In the Locustidæ there is presented to us one of the most remarkable developments in nature. A functional external difference in the two sides of an animal is indeed rare. Perhaps it does not occur elsewhere, yet every species of the Locustidæ possess this remarkable character in the wings. It is not observable in the Grillidæ, and certainly no other insects whatever do possess it. The inner basal portion of the right fore wings of the locusts consists of the broadened membrane and relatively more open-veined portion. This is the fiddle. The corresponding portion of the left fore wing is neither so membraned nor veined, but there is here a broad, stout vein situated very near the base which constitutes the bow. (See Fig. 3.)

Nature's habit of symmetry, however, has also placed this same bow vein, though less strongly developed, in the fiddle membrane of the right wing. It has become atrophied through disuse. (Fig. 3, *f* and *g*.)

During stridulation the wings of the locusts are held parallel to the body, the greater portion being vertical, and the musical basal portions horizontal and overlapping the back and each other. This brings the bow of the left wing in a position to move back and forth upon the edged and resisting veins that margin the membrane of the right wing. The bow, in order to cause greater friction, and therefore create sound, has, underneath, file-like ridges which are longest in the broadest portion of the vein. This roughness can be well seen with a low-power microscope.

In the locusts it consists of from twenty to one

Fig. 1.—Common Grass Locust. *Orchetimum vulgare.* Male Stridulating.

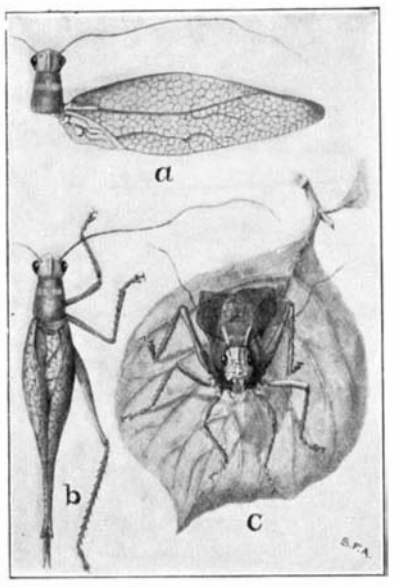


Fig. 2.—Angular-Winged Locust. *Microcentrum retinervis.* Male.

a. Right fore wing showing "fiddle" at lower base. *b.* Dorsal view with wings closed. *c.* Front view while stridulating.

hundred sharp straight ridges. In the crickets these are modified somewhat into T-shaped and scale-like elevations, and the bow is longer than that of the locusts; the wing motion, while stridulating, being more apparent.

The extreme convexity of the fore wings, the sound-producing portion being almost at right angles to the

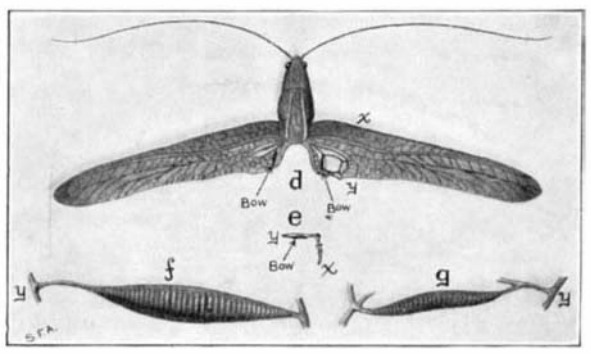


Fig. 3.—Cone Head Locust. *Conocephalus ensiger.* Male.

d. Head, prothorax and fore wings, showing fiddle and bows. *e.* Section of fore wing near base. *f.* Magnified bow in left wing showing file-like ridges underneath. *g.* Magnified bow in right wing. *x* indicates anterior margin and *y* posterior (inner) margin of wings.

vertical anterior portion, tends to stiffen the wing and apparently gives the fiddle a more resonant character. Where the sound is a continuous buzz or rattle, the fiddling motion is very rapid. The tree cricket, katydid, and other species move the wings slowly, as may be surmised from their notes. The sound produced by most species of the locusts and crickets is of a rasping character, just as one might expect from the study of the organs producing it. Some species, however, possessing no more rigid or otherwise varied music- distinctly produce organs, are very re- sounds that Most notable markable. latter is the among these ed locust angular-wing- *trum retiner- (Microcen- vis*), times called some- its superficial katydid, to that spe- from resem notes of the blance ed locusts are cies. The iation; they angular-wing- slowly and without var- When hear- simply begin fore their au- end rapidly. determined, ing them be- impossible to thorship is they emanate it is almost source. The imagine that much like from such a ing two small sound is al or hard that of strik- together rap pieces of met- ing a "chip, flinty pebbles How such idly, produc- sounds can chip, chip." the insect metallic ingly beyond emanate from Mr. Scudder crust is seem- explanation. and Hamil-

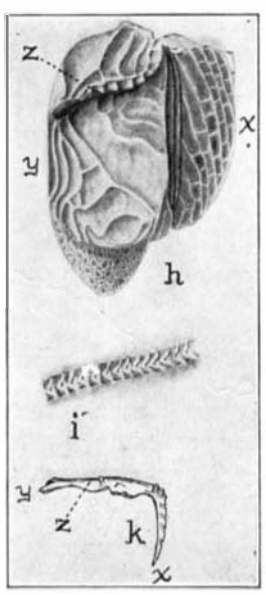


Fig. 4.—Right Fore Wing of Common Big Black Field Cricket. *Gryllus abbreviatus.* Male.

h. Wing flattened out. *i.* Magnified "bow" vein showing roughened scaly ridges underneath. *k.* Section of fore wing near its base. *x* indicates anterior margin and *y* posterior (inner) margin of wing. *z* indicates position of bow.

ton Gibson have faithfully described the music of many of our locusts and crickets. There is a wide variation between the notes of the different species; moreover, there is a difference between the night song and the day song of certain species. It is an interesting study, and the nature lover may easily profit thereby.

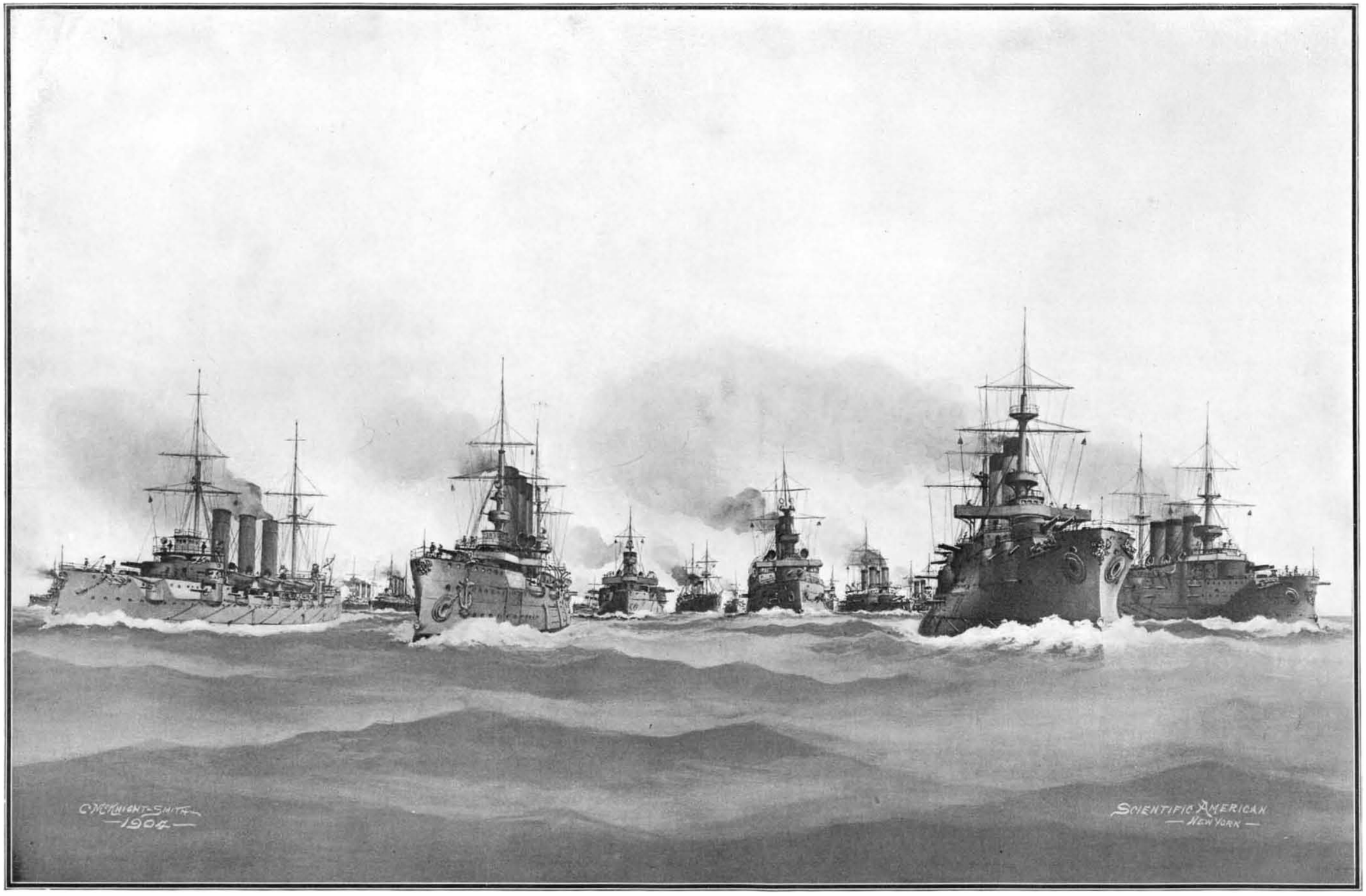
The Blue Color of the Heavens.

The blue color of the heavens is a subject which Prof. Spring of the Liege University recently treated in a conference before the Swiss Natural Science Societies during the late congress. He classes the explanations which savants have given up to the present as to the blue color of the heavens in two categories. The physical type is based mainly upon the experiments of Tyndall regarding the illumination of vapors. The chemical type is the more recent, and is based on the actual color of the atmospheric components. The former experiments which led to the physical theories of the blue color seem to have been borne out by the recent experiments of Rayleigh upon the reflection of light by the particles of a troubled medium, and these are found to reflect a great number of rays of short wave-length. This causes such a medium to appear red by transparence and blue by reflected light. Besides, the plane of polarization has the same direction as in Tyndall's experiments. M. Spring, however, absorbs all the blue light from the heavens by means of an appropriate absorbent medium, and thus observes that the polarization of the light in the beam is not a sufficient proof of the optical origin of the blue color, since it is demonstrated that other wave-lengths are polarized. The objections to Rayleigh's theory which are made by Pernter, of Vienna, strengthen his view; Rayleigh's theory would lead us to predict a violet color, rather than a blue, for the heavens. Besides, the dust particles of all kinds which the atmosphere contains do not rise to a height of over 3,000 to 6,000 feet, and the action of gravity and also the electric state of the atmosphere tend to precipitate them. The question arises whether it is the molecules of the gas itself which produce the solar reflection. This seems to be denied by L. Soret's experiments, which prove that this hypothesis does not hold good for liquids or solids, and more recently the author finds negative results in the case of gaseous particles. Hagenbach explains the illumination of the atmosphere by attributing it to a series of layers of different densities which cross and intermingle, thus causing reflection and refraction of the light rays. The author considers that such a theory would be satisfactory to account for the illumination, but cannot be used by the partisans of the physical theory to explain the color of the heavens. In fact, it accords very well with the chemical theory of the blue color. The author then made a series of original experiments to prove that a troubled medium will only seem blue to an observer who is plunged in it, in case the medium itself possesses a blue coloration. In the case of the atmosphere, the author upholds the theory of an inherent blue color by his calculation that the oxygen contained in the air, leaving out the possible effect of ozone, is sufficient to give the medium a deep enough color to explain its actual appearance and the variations we find in the different directions of sight. These calculations are based upon the liquid state of the gas. The dust particles, instead of being the cause of the blue color, only have the effect of obstructing it to a greater or less extent, and thus cause the variations which are observed.

The Current Supplement.

The title of the article that opens the current SUPPLEMENT, No. 1505, is the "Manufacture of Sawed and Sliced Veneers." The article was written after a careful study of a great plant near New York city, and the photographs were taken especially for our purposes. Of technological interest are an article on "Enamel and Its Present Application," and an account of electric welding with illustrations. Sir William Ramsay contributes some suggestive remarks on "Recent Chemical Research." Brigadier-General J. P. Farley writes on "Recoil," a subject which has engaged the careful attention of ordnance experts for some years past. A. W. Oppenheim contributes a valuable discussion on the Diesel engine, accompanying his analysis of its engineering possibilites by many diagrams. Prof. T. W. Richards writes on the relation of the hypothesis of compressible atoms to electrochemistry. "Scientific Agriculture" is a subject upon which William Somerville read a paper before the British Association for the Advancement of Science. Miss Agnes Clerke, one of several modern women famous in science, writes most instructively on the forms of nebulæ.

The Marquis de Dion has designed a new submarine of 100 tons displacement, to carry a crew of five, and driven by a motor of 200 horse-power. A model of the invention has been presented to the French Minister of Marine.



Cruiser Jemtchug. Cruiser Oleg. Cruiser Izumrud. Cruiser Svietlana. Cruiser Almaz. Cruiser Aurora. Cruiser Nakhimoff. Battleship Alexander III. Cruiser Dmitri Donskoi. Battleship Orel. Battleship Sissoi Veliky. Battleship Suvaroff. Battleship Navarin. Battleship Borodino. Battleship Osliabia.

THE BALTIC FLEET FOR THE RELIEF OF PORT ARTHUR.—[See page 318.]