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ORIGINAL ARTICLES.

I.—NOTES ON CERTAIN FOSSIL ORTHOPTERA CLAIMING AFFINITY WITH THE GENUS *Gryllacris*.

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(PLATE XIV.)

Eocene Tertiary ...	{	1. <i>Gryllacris Unger</i> , Heer. Figured and described by Heer in his <i>Insectenfauna</i> , 1849, s. 8, t. i.
		2. <i>Gryllacris Charpentieri</i> , Heer, op. cit. s. 12, t. i.
Coal Formation ...	{	3. <i>Gryllacris lithanthracis</i> , 2 species. Figured and described in <i>Palæontographica</i> , bd. iv. p. 25 and 28, t. iv. 1-2.
		4. <i>Corydalus Brongniarti</i> , Aud. Buckland, vol. ii. p. 77.

The above five insect remains, claiming affinity with the modern genus *Gryllacris*, of the order Orthoptera, retain for the investigator no characters in common, but such as may be afforded by the central portion of the principal disk or internominate field of the elytron, and by the lesser marginal field. From comparison of these areas in the specimens from the Coal-measures, as regards configuration and venation, a certain similarity of design is observed, and a general correspondence detected. By taking Heer's descriptions and figures as data, this character is seen to be reproduced—less markedly distinct from the type observable in certain species of the modern genus of Burmeister—both in the profile of *G. Unger* and in other fragments preserved to us in the Eocene strata of the Continent. Complete identification of these species must be the reward of future investigators.

The most perfectly preserved venation is presented by the fragment of *C. Brongniarti*, hitherto reputed a Neuropterous insect, closely allied to the living *Corydalus* of Carolina, and exhibited as such by Audouin at the meeting of the Naturforscher at Bonn in the month of September, 1835, but which Heer seems rather to indicate as belonging to the Orthoptera; and this latter view, it will I think be seen, is quite agreeable to the venation and peculiarities of construction exhibited in its wing, an object of undoubted beauty, revealed by the fortuitous fracture of a nodule of Clay-ironstone, and now preserved in the British Museum. The history of this specimen is somewhat wrapt in obscurity. It was purchased by Mantell at the sale of Parkinson's collection, the latter, there is reason to suppose, having obtained it from the neighbourhood of Colebrook-dale. It was subsequently transmitted to M. Brongniart, and has been described by Audouin (*Buckland, Geology and Mineralogy*, vol. ii. p. 77). In the Museum specimen of *G. Unger* the

wing venation is in some measure preserved, but is somewhat difficult to trace. The figure of it given by Heer, having been obtained from the obverse of the impression, which retains the left elytron intact, gives a little more of the cross venation. The *G. Charpentieri*, figured by Heer, is by no means a perfect exposition of this specimen.

GRYLLACRIS (recent species). Under side of right elytron, see Plate XIV. Fig. 1.

The species of *Gryllacris* are intermediate in character between the crickets and swamp-loving leaf-crickets, the *Locustina* of German authors, of which the great green grasshopper (*L. viridissima*), so partial to our potato fields, is a familiar example. Their haunt is the banks of the warm streams of India or Brazil. MacLeay, on recording his capture of a specimen in such a situation in Australia, remarked a mimicry in these insects to the Neuroptera. Their enormous antennæ, more than twice the length of the wing-covers, are probably a protection. They carry their elytra folded in a way peculiar to themselves. Thus while in the crickets we find the marginal field of the elytron turned down at a right angle to the remaining portion, and in the leaf-crickets the marginal and internominate fields giving a character to the insect by their roof-shaped attitude, in *Gryllacris* the marginal field brings the internominate over with it as far as the line described by the internominate vein, and causes the elytra to present a rounded or somewhat hexagonal superficies at their base, in the position of repose, so that the wing-covers are more inclined than those of the crickets, and less inclined than in the leaf or tree-crickets.

Figure 1 gives the notation of the veins on the system adopted by Heer, which admits also of tabulation, thus :—

Mediastinal vein (unimportant)	Marginal field.
1 and 2. Scapular vein (bifurcate)	Internominate field.
3. Externominate vein	
4. Internominate vein	
5 and 6. Anal vein (this vein presents two stems) ...	Anal field.

Having analyzed a tolerably complex form of elytron as to vein branches, and noticed the primal character afforded by its folding to constitute a case or cover for the hind wings, the task of examining the character of fossilized elytra that may seem to have affinity with those of *Gryllacris* will be in some measure facilitated.

Gryllacris Unger (restored). See Plate XIV. Fig. 2.

As the remains of examples of this genus from the Eocene strata are fully described by Heer in his *Insectenfauna*, I will content myself with some observations on the interesting profile of *G. Unger* in the British Museum, of which Fig. 2 is an attempted restoration.

In this case we have the thorax, abdomen, head, antennæ, wings, legs, tarsi, claws, etc., of a probably extinct insect of the Saltatorial Orthoptera, preserved on a slab of Eocene Tertiary grey-coloured (freshwater) Limestone, associated with stems of rushes or other

grass-like leaved aquatic plants. The under side of the left elytron is seen with many of its veins intact, and I have succeeded in reproducing the longitudinal framework (see Woodcut, Fig. 5). The right elytron is present only as an impression.

FIG. 5. Diagram of the longitudinal framework of the under side of the left elytron of *Gryllacris Unger*, Reer.

The surface of the mud tablet bearing the delineation of the *Gryllacris* reveals to us the aqueous nature of the vegetation of the locality where it once found its home and the nature of its food plants. It has been restored as crawling on a specimen from its associated herbarium, a kind of extinct pond-weed, or rather tassel-grass (*Ruppia*). Some scales and the vertebrae of a small fish lie on the stone just in advance of its head, in the original; and assist in elucidating and illustrating this page of its natural history.

Although probably never gazed on by human eyes, this grasshopper was not devoid of ornament. It had spotted elytra or wing-covers, and boldly blotched or perhaps coloured under wings; so that while thus it recalls to our mind the most handsome group of recent species of *Gryllacris*, it also connects them, as I shall endeavour to show, by an exposition of the venation of the elytra, with more ancient Orthopterous forms that peopled our earth in the dim and far-off Carboniferous ages.

Corydalis Brongniarti, Audouin. Under side of right elytron, see Plate XIV. Fig. 3.

This species, before noticed, from the Coal-measures of Coalbrookdale, Shropshire, is preserved to us in a wing, presumably the left elytron, of an Orthopterous insect, lying on the cleft nodule, with its under surface, on which it very probably rested during its interment, exposed.

This specimen, previously remarkable for the delicate venation it displays, acquires additional interest in a serrated vein that lies near its base: with little doubt the active agent of an organ of stridulation, similar to that possessed by the male house-cricket, and with which this insect effects its incessant "cree-cree."

To begin with the venation of the wing. If we compare the elytron of *G. Unger*, Fig. 5, with that of the modern *Gryllacris*, shown on our Plate at Fig. 1, it is at once seen, that although the venation has in each instance the same typical sub-parallel arrangement of its longitudinal branches, in *G. Unger* the limbs 1 and 2 of the scapular vein lie closer together, are *more parallel*, and the principal limb (2) forms an *elbow* or obtuse angle before its middle

This peculiarity, while it increases the transverse rigidity of the pin'on, and seems to contract the marginal and internominate fields, also *approximates* the externominate vein (3) to the principal limb of the scapular (2), with which it coincides a little before the elbow.

If we now turn to the Coalbrook-dale elytron, Plate XIV. Fig. 3, we see this characteristic well marked, but in conjunction with other elements, which deserve prominence from the indications they afford us of a slight aberration from the minor characters in a wing of the cricket or *Gryllacris* type, this is obviously in accordance with the increase of wing area, which here, it will be observed, is twice as great as that of any recent species with which we are acquainted. These modifications are briefly comprised in the greater branching of the large longitudinal veins, and occasional dividing of the transverse veinlets that brace them together, with the less parallel disposition of the former. It is to be regretted that the imperfect preservation of the Eocene insects forbids the institution of accurate comparisons on these points, which certainly indicate a greater expanse or decrease in toughness or elasticity in the wing membrane; and the more so as this wing seems to constitute a type to which the fragments of the *G. lithanthraca*, Heer, from the Saarbrück Coal-fields, may be referable.

File.—As a rule the file characterizes the male of the crickets and leaf-crickets, and although I cannot succeed in finding a species of *Gryllacris* with an effective file, it may nevertheless sometimes be found beneath the base of the elytron of these insects in a membranous form, as seen in Plate XIV. Fig. 1. Little more is to be gained from an examination of the remains of *G. Unger*i, which only presents a circular vein of questionable import at the base of the under side of the right elytron, marked by a few doubtful indentations.

In the Coalbrook-dale elytron the file is well marked, and judging from the fact of its traversing the internominate field of the elytron, its form, the character presented in its lower extremity, where the teeth are largest, it exhibits to us the nearest resemblance to the file or lima of the male house-cricket, as figured by Newport or Landois. (I have by me drawings of the file of the male European house and field-crickets, and hand specimens of those of the males of various leaf-crickets.) The house-cricket, as is well known, "sings" by partially opening and shutting its raised elytra, during which the file on the under side of the upper moves its teeth somewhat diagonally over a vein at the upper surface of the opposite elytron or wing-cover placed beneath, as Goureau has long ago informed us in his able and interesting paper contained in the *Annales de la Soc. Entomol. de France*. The mechanism of its file, as shown at Plate XIV. Fig. 4, is from a drawing by Newport, and the microscopic structure has recently been thus described by Landois:—

"Each wing-cover in the cricket has a shrill vein for vibration, analogous in form and position to that of the field-cricket. On its under surface are numerous bridges, about 200 in number, projecting from and placed crossways on the vein. In the cricket the bridges

are placed much closer than in the field-cricket, and their free and upper edges are somewhat longer. Their shape is a half-moon, and they are severally fastened to the shrill vein by a kind of columnar prop at their centre. They are not quite perpendicular, but placed slightly obliquely; and the friction takes place at their flat and concave upper edges when the wing-covers are rubbed or fiddled upon one another. These bridges are not of like dimensions, and at the origin and termination of the shrill vein are very small and poorly developed, and of little power in stridulation. In the central part of the vein they are well developed. They amount to something like 143, and have the following dimensions: Breadth, 0·0028 in.; height, 0·0005 in.; breadth of the prop, '0011 in."

The microscopic character of the file shown by the fossilized elytron of *G. Brongniarti* may be thus generally given.

The lower part is broken away, so that the portion remaining in the anal field shows only ten large teeth, each 0·15 in. broad, of triangular profile; these run obliquely across it, and present their vertices or edges to the fore-margin of the elytron. These teeth or bridges are then attenuated from the point where they enter the internominate field; more than twenty are observed to traverse in a flattened curve, in a direction almost at a right angle to their former course, to the vicinity of the scapular vein, where they vanish: the whole adjustment presenting the curved line of a flat parabola or ellipse, with semi-major and minor axes of 0·16 in. and 0·1 in.

Thus, then, we see that this ancient instrument of music had already attained, to all appearance, an efficiency at least thrice that of our modern house-cricket, and must have emitted notes that rang widely over the tropical forest that clothed our island in the old days of the Coal period; and we may conjecture that each afternoon and evening it enlivened the stilly watery surfaces with its dull and incessant scraping.¹

These plaintive love-notes, weird and wild, doubtless evoked a thrill of kindred emotion in the bosoms of numberless Batrachia, who found a home amid the swamps and morasses abounding in those ancient Cryptogamic Forests, and who answered, by a chorus of equal sweetness, the music of their Orthopterous companions.

EXPLANATION OF PLATE XIV.

FIG. 1.—*Gryllacris* (recent). Under surface of left elytron. Twice natural size.

1 and 2. The bifurcate scapular vein.

3. Externominate vein.

4. Internominate vein.

5 and 6. Anal vein.

FIG. 2.—*Gryllacris Unger*, Heer (restored). From the Eocene Tertiary, Radoboj, Austrian Croatia. Natural size. Plant, *Ruppia pannonica*, Unger.

FIG. 3.—*Gryllacris (Corydalus) Brongniarti*, Audouin, sp. Under surface of left elytron, showing what appears to be the file of an Orthopterous insect.

FIG. 4.—File of the organ of stridulation of the common house-cricket, from Newport's figure in Tod's Anatomy. Much magnified.

¹ Indeed it must have done so did its possessor at all aspire to the habits of two great sections of our modern Saltatorial Orthoptera.