

not alter the evidence of the existence of the Primordial Fauna in Newfoundland, for both genera are characteristic of it. The important point is this. From the occurrence of these fossils in the same beds as the *Paradoxides Bennetii*, Salter, we should naturally look for something representing them in the slates at Braintree. And I have the pleasure of stating that during the last summer I found a fragment at Braintree, which I find to belong to the same genus as the new specimens from Newfoundland.

I have also found at Braintree a distinct fucoidal impression which shows three branches, each about four inches long, but not sufficiently well marked to afford any evidence with regard to its nature.

These two discoveries, although slight, show us the existence of a variety of organic remains in the Braintree slates, and incite us to further investigations. And I hope that the next summer will not pass without further developing their riches, and affording us some new facts with regard to the Primordial fauna of the eastern portion of America.

ON THE GENUS *RAPHIDOPHORA*, SERVILLE; WITH DESCRIPTIONS OF FOUR SPECIES FROM THE CAVES OF KENTUCKY, AND FROM THE PACIFIC COAST. BY SAMUEL H. SCUDDER.

In 1839, Serville, in his *Histoire naturelle des Orthoptères*, characterized, among the *Locustariæ*, the genus *Raphidophora*, from a single species from Java, *R. picea*. Burmeister in the previous year, had described the same insect, in his *Handbuch der Entomologie*, under the specific name *loricata*, and placed it in the genus *Phalangopsis* of Serville, together with other species of either genus, separating them from one another as different sections of the same genus; he, however, discovered his mistake before the completion of his work, and in the appended corrections, notices "that the species of the first section appear to belong to the following family," (*Grylloidea*;) and subsequently (*Germar's Zeitschrift für Entomologie*, II. 72), he asserts that his second section, in which occurs his *P. loricata*, is identical with Serville's genus *Raphidophora*.

Misled by Burmeister's error, in the body of his work — where he describes one species "*P. lapidicola*" from the United States, without much doubt, identical with the well-known *R. maculata* of Harris, — and overlooking the correction made by Burmeister himself in his appendix and in *Germar's Zeitschrift*, and probably also noticing the strong general resemblance of *P. longipes*, of Central America, as figured in Serville's work, to our "wingless crickets," all the species found with us have been referred by American entomologists to the genus *Phalangopsis*. A careful examination will prove that they all belong to the genus *Raphidophora*, no species of *Phalangopsis* having been yet described from the United States.

The following table exhibits the synonymy of the hitherto described species of *Raphidophora*, so far as known to me :—

1. *Raphidophora loricata*, Burm. Germar, Zeitschrift f. Ent. II. p. 72.
Phalangopsis loricata, d. Haan, Burm. Handbuch der Ent. II. p. 722.
Raphidophora picea, Serv. Hist. nat. p. 391 (Java).
2. *Raphidophora palpata*, Charpentier, Orth. descr. et depict. pl. 44.
 " " " Germ. Zeitsch. III. p. 319.
 " " Fischer, Orth. Eur. p. 200.
Locusta palpata, Sulzer, Abgek. Gesch. d. Ins. p. 83.
Raphidophora araneiformis, Charp. Germ. Zeitsch. III. p. 319.
Phalangopsis araneiformis, Germ. Burm. Handb. II. pp. 722, 1014.
Phalangopsis araneiformis, Herr-Schaeffer Nomencl. II. pp. 15, 26 (Europe).
3. *Raphidophora cavicola*, Fischer, Orth. Eur. p. 301.
Locusta cavicola, Koller, Beiträge zur Landesk. III. Wien, 1833. p. 80.
Phalangopsis latebrarum, Herr-Schaeffer Nomencl. II. p. 15.
Phalangopsis latebricola, Herr-Schaeffer Nomencl. II. p. 26 (caves in Europe).
4. *Raphidophora lapidicola*, Burm. Germ. Zeitsch. III. p. 319.
Phalangopsis lapidicola, Burm. Handb. p. 723.
? *Raphidophora maculata*, Harris, Ins. injurious to Veg. Ed. 1841, p. 126.
? *Ephippigera maculata*, Harris, Cat. Ins. Mass. p. 56.
? *Phalangopsis* " " Ins. injurious to Veg. Ed. 1852, p. 137.
(The posterior tibiae of the male of this species are not waved at the base, as asserted by Haldeman, Proc. Am. Ass. Adv. Sc. II. p. 336) (United States).
5. *Raphidophora gracilipes*.
Phalangopsis gracilipes, Hald. Proc. Am. Ass. Adv. Sc. II. p. 336 (Pennsylvania).
6. *Raphidophora scabripes*.
Phalangopsis scabripes, Hald. Proc. Ac. Nat. Sc. Phil. VI. p. 364 (Alabama).

It was first mentioned in 1844, by Telkampff,* in connection with descriptions of the blind fish of the Mammoth Cave, that a species of

* Telkampff: Müller's Archiv für Anat. und Phys. 1844, p. 318.

Wiegmann's Archiv für Nat. 1844, p. 284.

Thompson: Annals and Magazine of Nat. Hist. 1844, p. 111.

Agassiz: Silliman's Am. Journ. of Science. 1851, p. 127.

Schiodte: Kongl. Danske Vid. Selsk. Skrift, 1849, p. 5.

Fischer: Orthoptera Europæa, 1853, p. 200.

Phalangopsis-like Orthopteron was also an inhabitant of the cave; and though subsequent mention, in similar connections, has been made by Thompson, Agassiz, Schiödte, and Fischer, no further account has been given of it than that it resembled the *P. longipes* of Serville.

Having been lately favored with specimens of two species, collected in different Kentucky caves, by Mr. Alpheus Hyatt, and of one of them by my brother in the Mammoth Cave, and having also had the opportunity given me of examining numerous specimens of both in the Museum of Comparative Zoölogy in Cambridge, I take this opportunity to give a more exact account of them than has hitherto been done. I am indebted to my brother and to Mr. Hyatt for the information I have given respecting their habits.

Raphidophora subterranea, nov. sp.

Fuscous *, under surface of body, the head except vertex, both pair of palpi except extremities, coxæ, under side of femora, terminal third of tibiæ, and the tarsi except the under edge and extremities, paler; some faint reddish-brown spots on upper surface of thoracic segments. A much depressed, scarcely perceptible carina along the dorsum. All the appendages densely covered with short, fine, microscopic hairs.

Antennæ dark brown at base, becoming paler toward the tip; first joint stout, somewhat flattened anteriorly, obliquely truncated interiorly at the base; second joint half as long and as broad as first, compressed anteriorly; third cylindrical, as long as first, at base of the same breadth as second, but narrowing rapidly, though but slightly; remainder of unequal length, but averaging, at first, half the length of the third joint, slowly diminishing in size, so that the whole tapers very gradually to the very delicate extremity. Tip of the last joint of the maxillary palpus with a slight excavation interiorly. Eyes black, subovate, subglobose.

Four anterior coxæ carinated externally, the carina of the two anterior being produced into a central spine. A double row of distant, alternate, short spines on under side of the four anterior tibiæ, with two upon either side at the extremity, of which the lower is largest, embracing the base of the tarsi; posterior tibiæ with a double row of minute sharp spines, extending nearly the whole length of the hinder portion, raised at a very small angle, interrupted by longer, distant, and alternate ones, elevated to a higher angle; upon the anterior lower third are two approximate rows of distant spines; three spines at the extremity upon either side, embracing the first joint of the tarsi, the first and third of a nearly equal size and appearance to the larger tibial spines, while the second is three times

* The colors of both species are described from specimens dried after a long immersion in alcohol.

as long, and thickly covered with short, fine hairs; all the longer spines are movable and tipped with reddish-brown, approaching to black; terminal half of claws black.

Ovipositor rufo-testaceous, swollen at the base, flattened in the terminal two thirds, nearly straight, slightly curved upwards and ensiform at the tip, produced to a sharp point with five or six serrations on the lower edge of extremity of inner valves, but hidden by the outer ones; anal cerci tapering to a fine point, furnished, besides the short hairs common to all the appendages, with exceedingly fine long ones, shortening toward the apex.*

MEASUREMENTS. THE AVERAGE OF MANY SPECIMENS. Anterior femora, .54-inch; ant. tibiæ, .59-inch; middle femora, .49-inch; middle tibiæ, .59-inch; posterior femora, .84-inch; posterior tibiæ, 1.08-inch; antennæ (longest), 4-inch; maxillary palpi, .50-inch; ovipositor, .52-inch; cerci, .26-inch; whole body (as curved), .66-inch.

This species is the one inhabiting the Mammoth Cave of Kentucky, and the adjoining White's Cave; they were found throughout the cave to the remotest parts (seven miles or thereabouts), though not near the entrance, especially in damp, moist situations, where they abound; they were found in especial plenty about "Martha's Vineyard," and in the neighborhood of "Richardson's Spring," where they were discovered, jumping about with the greatest alacrity upon the walls, where only they are found, and even when disturbed, clinging to the ceiling, upon which they walked easily; they would leap away from approaching footsteps, but stop at a cessation of the noise, turning about and swaying their long antennæ in a most ludicrous manner, in the direction whence the disturbance had proceeded; the least noise would increase their tremulousness, while they were unconcerned at distant motions, unaccompanied by sound, even though producing a sensible current of air; neither did the light of the lamp appear to disturb them; their eyes and those of the succeeding species are perfectly formed throughout, and they could apparently see with ease, for they jump away from the slowly approaching hand, so as to necessitate rapidity of motion in seizing them. Late in October, females were obtained enormously distended with eggs.

Raphidophora stygia, nov. sp.

Body pale brown, with the segments bordered posteriorly with dark brown or black, becoming gradually paler toward the hinder part of the body, and dotted with pale spots. Head pale brown, a black spot beneath each eye, and another midway between these. Eyes black, subpyriform, subglobose. Appendages of the mouth dirty pale. Antennæ yellowish brown, paler toward tip, obscurely and distantly

* A more detailed account of the abdominal appendages cannot be given till the homologies of these parts are carefully studied and their nomenclature rectified.

annulated with narrow pale bands; first joint with a central faint brown annulation, shaped as in *subterranea*, but less flattened and truncated; second joint very small, with lateral constrictions; third joint as long as first, cylindrical; fourth joint half as long as third; remainder unequal but very short, and continuing of the same average length, while they become more slender toward the extremity. Last joint of maxillary palpus split interiorly almost its entire length.

Lateral edges of thoracic segments minutely marginate; the pronotum is bordered in front as well as behind with brown, and is irregularly mottled with black and dirty yellow. Legs pale-yellowish, femora and tibiæ and joints of tarsi beneath, especially at extremities, more or less clouded with brown. Coxæ as in *subterranea*; there are three or four distant spines on the upper part of the inner edge of anterior femora, and upon the upper part of both posterior edges of middle femora; the internal terminal lobes of the middle femora also gives rise to a short spine; spines on under side of four anterior tibiæ, same as in *subterranea*, except that the spines of the parallel rows are opposite or nearly so. Posterior femora barred and cross-barréd with dark brown bands; beneath, two rows of serrations or rudimentary spines; tibiæ as in *subterranea*; spines and claws tipped with reddish brown.

Ovipositor brown; thickened at base, flattened posteriorly, nearly straight, very slightly curved at the end, the tip with a dull point; inner valves at their extremity waved beneath into three or four dull points, hidden by the outer valves. Anal cerci brown, beset with long delicate hairs, as in *subterranea*.

MEASUREMENTS. AVERAGE OF MANY SPECIMENS. Anterior femora, .34-inch; ant. tibiæ, .36-inch; middle femora, .31-inch; middle tibiæ, .35-inch; posterior femora, .71-inch; post. tibiæ, .76-inch; antennæ (longest), 3.44-inch; maxillary palpi, .33-inch; ovipositor, .51-inch; cerci, 25-inch; body (as curved), .80-inch.

Nearly opposite Hickman's Landing, upon the Kentucky River, there is a large cave, a mile or more in extent, which has received no name; quite near it, farther up the river, is a much smaller one, a few hundred feet only in extent; in this latter place the *stygia* is found,—for convenience' sake we may call it "Hickman's Cave;" though search was made in the larger cave, no *Rhaphidophoræ* were found, but in the remotest corner of Hickman's Cave, in a sort of hollow in the rock, not particularly moist, but having only a sort of cave-dampness, the *stygia* was found plentifully; these were also found exclusively upon the walls. Even the remotest part of the cave is not so gloomy but that some sunlight penetrates it.

The relations of these cave-insects to other *Rhaphidophoræ* are very interesting. *R. stygia* inhabits a cave only a few hundred feet from the sunlight; *R. subterranea* deep caves, scarcely ever within a mile

of the opening; *R. maculata* of Harris lives beneath logs and stones. By a comparison of the minutiae of the structure of these three species, it will be seen that *R. stygia* holds middle ground between *R. maculata* and *R. subterranea* in the length and slenderness, as well as the shape of the joints of the antennæ, in the form of the dorsal portion of the thoracic segments, in the spines of the edges of the femora and of the terminal lobe of middle femora, in the stoutness of all the legs, in the form of the ovipositor and the teeth of its inner valves, in the abdominal appendages, of which I have not made mention, in the general contour, and even in the coloration of the body; there seems to be but one exception where *stygia* is more nearly allied to *maculata* than to *subterranea*, and that is in the structure of that part of the terminal joint of the maxillary palpus, which Burmeister considers as the organ of touch; further on, I shall mention their relation to those of the Pacific coast.

Raphidophora Agassizii, nov. sp.

Body dirty yellowish brown,* with the segments bordered posteriorly — and the pronotum anteriorly — with black. Head yellowish brown, slightly marked above with darker wavy lines, palpi pale yellow, antennæ yellowish brown becoming paler toward the tip; first joint large, flattened, rounded interiorly, joints immediately succeeding cylindrical, of nearly equal diameter, but the whole antenna tapering toward the tip; second joint as long as its diameter; third, twice as long; fourth, one half longer than its diameter: fifth and succeeding joints subequal, half as long as fourth. Eyes black, subpyriform, subglobose.

Thoracic segments much mottled with yellowish brown; there is a faint pale dorsal line which extends over the head, and through the tubercle of the vertex, interrupting a brown band between the eyes. Coxæ, upper part of femora, the lower part of the tibiæ sometimes, and tarsi, yellowish brown; posterior part of the femora and tibiæ darker; basal portion of posterior femora brownish yellow, barred and obliquely cross-barréd with dark brown. All the appendages and posterior half of abdominal segments covered with short fine hairs. Under edges of the anterior femora serrated, with a single spine or two upon the inner edge near the extremity; middle femora with both edges distantly spined; internal terminal lobe of middle femora armed with a spine, and sometimes the external lobe has a very slight one; a double row of alternate spines on the upper side of middle tibiæ, and a double row of opposite spines on under side of both anterior and middle tibiæ, the terminal ones of all the rows being longest. Posterior femora with two rows of minute black spines on the posterior portion interrupted by larger, distant, nearly opposite

*Described from alcoholic specimens.

spines; terminal spines as in *stygia*, but smaller, the longest with scarcely perceptible hairs. Longer spines movable; tips of spines and claws, reddish black.

Ovipositor reddish brown, darker at base, a little curved and slightly turned upwards at the tip, which is produced to a fine point; the inner valves are as in *stygia*, with the dull points produced to delicate spines, the terminal ones slightly recurved and none concealed by the upper valves; anal cerci brown with long fine hairs, longer in the male than in the female.

MEASUREMENTS. AVERAGE OF MANY SPECIMENS. Anterior femora, .24-inch; ant. tibiæ, .26-inch; middle femora, .24-inch; middle tibiæ, .26-inch; posterior femora, .55-inch; post. tibiæ, .58-inch; antennæ (longest), 1.86-inches; maxillary palpi, .25-inch; ovipositor, .34-inch; cerci, ♂ .19-inch; ♀ .12-inch; whole body .80-inch.

Obtained on islands in the Gulf of Georgia, under stones, by Mr. A. E. R. Agassiz, after whom I take pleasure in naming it. The specimens are in the Museum of Comparative Zoölogy, at Cambridge.

Raphidophora xanthostoma, nov. sp.

Body brown, pro- and mesonotum faintly mottled with yellowish brown. Head (except the parts of the mouth) dark brown, mottled with pale yellowish; labrum, mandibles, maxillæ, labium, and labial palpi bright straw yellow, with some reddish spots; maxillary palpi, brown and dirty yellow; tubercle of the vertex ridged with dirty yellow, and upon either side a yellow spot; antennæ reddish brown, first two joints darkest, first joint flattened at the base, slightly excavated exteriorly, obliquely truncated interiorly on the basal half, truncated obliquely at the extremity; second joint, cylindrical, half as broad, and one third as long as first; third, twice as long as second, as broad as it is at its junction, narrowing slightly, remainder subequal, a little shorter than second. Eyes subovate, globose.

Sides of thoracic segments emarginate, edged with yellow becoming paler on the metanotum, and reddish on the anterior of pronotum. Legs reddish brown, darkest at the extremities of femora and bases of tibiæ; both sides of posterior tibiæ faintly spotted with equidistant yellowish spots; four anterior tarsi yellowish, with very faint brown bands across the sides; posterior tarsi brown with the joints tipped with yellowish, and having a faint dirty yellow line beneath. Outer posterior edge of anterior femora not covered, as the others, with fine spines; both under edges of middle femora spiny at their terminal half; inner lobe of the extremity of two posterior pair with a small spine; both upper edges of posterior femora supplied with fine spines as far as basal half of the swollen portion; three pair of dark brown spines at the extremity of posterior tibiæ, of which the middle is largest, fully twice as long as the others, with a few very fine short distant hairs upon it, the other spines reddish brown, except the bases

of those near the extremity of the tibiæ, which are yellowish; claws, reddish brown, darkest toward tip. Anal cerci stout, yellowish brown, dotted with dirty white, each dot at the base of a delicate hair.

MEASUREMENTS. Anterior femora, .62-inch; ant. tibiæ, .68-inch; middle femora, .60-inch; middle tibiæ, .73-inch; posterior femora, 1.10 inches; post. tibiæ, 1.30 inches; antennæ (broken), 2.00 inches; maxillary palpi, .35-inch; cerci, .18-inch; whole body, .70-inch.

This species is one from a rich collection brought home by Mr. Agassiz from the Pacific coast; it was taken at Crescent City, California, under a large stone; only one specimen was obtained. In the Mus. Comp. Zoöl., Cambridge.

Raphidophora xanthostoma does not belong to the genus in which I have placed it, but is the representative of one closely allied, though perfectly distinct. I do not now characterize it, because I have only a single male specimen to examine, insufficient to give with accuracy and fulness the characteristics of the genus in which it must eventually be placed; it will be sufficient here to say, that it will be found to differ from *Rhaphidophora* in the more rounded front of pronotum, in the more distant and globose eyes, in the very prominent and deeply cleft tubercle of the vertex; there is a marked difference, in that all the femora and tibiæ are rectangular, and the edges minutely spined, except the swollen portion of the posterior femora, which also partakes of this character in its posterior half; the two anterior pair of tibiæ are noticeably longer than the femora, while they are equal in *Raphidophora* proper; the anal cerci are blunt at the extremity and channelled interiorly; all three pair of coxæ are carinated externally, and the epimera of the thoracic segments are produced to emarginate lamellæ which almost overlap the base of the coxæ; the sides of meso- and metanotum are not prolonged downward below the pronotum, and the lower edges of all the coxæ are produced on the inner side to a small dull spine.

On placing these *Rhaphidophoræ* of the Pacific coast side by side with those from the other side of the Rocky Mountains, one cannot but be struck with the peculiar correspondences of structure seen. On certain theories of the origin of species, one would instantly pre-
 judge them to be most closely allied to *R. maculata*, Harris; on the contrary, by examining those parts of their structure which I have mentioned in my previous comparison of *maculata*, *stygia*, and *subterranea*, it will be seen that *Agassizii* recalls most vividly *stygia*, while *xanthostoma* is most closely allied to *subterranea*, they being in short, representative species of distinct faunæ. *R. Agassizii* will be found closely related to *R. stygia* in the shape of the basal joints of the antennæ, the terminal opening of the last joint of the maxillary palpus, in the shape of the legs, in the spines of the four anterior femora, in the form of the ovipositor and the spines of the inner valves, in the ab-

dominal appendages of the male, and in the general markings of the whole body; and as this species from the Gulf of Georgia is found to be most closely allied to the *Raphidophora* of the shallow cave, so that from California, in the minutiae of its structural peculiarities, reminds us of that from the deeper cave; this will be seen in the shape and comparative size of the basal joints of the antennae, in the compressed terminal joint of the maxillary palpus, as well as in its interior split, and in the length and slenderness of the legs; whilst in the tubercle of the vertex, in the shortening of the meso- and metanotum, and in the proportional length of the four anterior femora to the tibiae, *R. subterranea* even approaches the genus to which *xanthostoma* belongs.

The Javanese species, *R. loricata*, Burm. (according to Serville's description), differs from all our species, in the form and comparative size of the terminal joint of the maxillary palpi, in the coxae of mesothorax, in the terminal spines of the four anterior femora (from which characteristic Serville derives the generic name), in the character of the terminal spines of posterior tibiae, in the non-compressed form of tarsi, and the presence of spines upon their first joint, and (in most) in the comparative length of the cerci.

From the European species, *R. palpata*, Charp., and *R. cavicola*, Fisch., ours differ mostly in the form and comparative size of the ovipositor, and I might add also in the general structure of the abdominal appendages, were it not certain that Fischer's description of these parts was taken from dried specimens, which could not exhibit their true character.

NOTE. In my comparisons I have made frequent mention of *R. maculata*, Harris, which is mentioned in the synonymical table as the same as *R. lapidicola*, Burm. I have not used the latter name, because I am sure that the insects before me were the *R. maculata*, Harr., while I am not equally confident that they were the *R. lapidicola*, Burm.

DESCRIPTIONS OF SHELLS COLLECTED BY THE NORTH PACIFIC
EXPLORING EXPEDITION. BY DR. A. A. GOULD, (*continued.*)

TECTARIUS LUTEUS. *T. parva*, biconica, lutea, epidermide calcareâ incrustata, lineis incrementi tenuibus et lineis volventibus minutissimis antrorsum crescentibus reticulata; anfr. 7, conicis, acutè carinatis, ad suturam imbricantibus et subnodulosus: apertura rhomboidea; labro acuto; columellâ callo erecto indutâ. Axis, 6+; diam. 4 millim. Inhabits China Seas. W. S.

A curious little shell which I was at a loss at first where to place; but, on the whole, do not hesitate to place it under this genus.

SIGARETUS LUCIDUS. *T. parvula*, depressa, candida, tenuis, lineis incrementi et striis volventibus reticulata; anfr. 3+, apice e margine remoto, regione umbilicali concavo, calloso, minutè perforato;