The first half hour was devoted to a discussion of Dr. Gill's paper presented at the last meeting. Dr. Gill stated the main features of his paper, after which it was discussed by Messrs. Stiles, Smith, Riley, Gill, Banks, and Ashmead.

Dr. Riley then read the following papers:

ON CERTAIN PECULIAR STRUCTURES OF LEPIDOPTERA.

By C. V. Riley.

1. The Radiate Bodies in the Receptaculum Seminis of Pronuba and Prodoxus.

In preparing a résumé of the facts connected with Yucca pollination for the Annual Report of the Missouri Botanical Garden, I had occasion lately to characterize definitely the undescribed species of Pronuba and Prodoxus, and in connection with the descriptions presented herewith for publication I would call attention to some of the peculiar structures of these remarkable insects. *Pronuba synthetica* pollinizes *Yucca brevifolia*, and is a rather anomalous Lepidopteron, bearing a striking superficial resemblance to certain saw-flies of the genus Dolerus, as also to certain Neuropterous species of the family Sialidæ. Aside from the curious maxillary tentacles and serrate ovipositor of the female, peculiar to the genus, the body is flattened and the scales of the wings so loosely attached and so sparse that they disappear as readily as in the case of the Sesiidæ, and are seen in perfection only in the recently emerged individuals. But it is not the external peculiarities of this insect to which I wish to draw attention in this note so much as the peculiar radiate bodies in the *receptaculum seminis*, which, if they occur at all in other insects, are never found in anything like the remarkable development in which they exist in the species of the family Prodoxidæ. In the very first studies of *Pronuba yuccasella* these radiate bodies were noticeable, and have been referred to by me as being visible even through the sides of the body when this is rendered in any way transparent. They consist of a pair of brown, chitinous radiate structures, each with a darker central circular ring or hub. More closely studied this circular ring is seen to represent the end of a hollow though shallow cylinder, from the sides of which the spicules radiate. The individual spicules have an inner groove or channel running from the very tip to the base. I present some drawings which will indicate the relative size of the pear-shaped receptaculum in the three known species of Pronuba and in *Prodoxus decipiens;* also the relative dimensions of the radiate bodies. It will be seen that they are very much the largest in *Pronuba yuccasella.* In *Pronuba synthetica* they are next in size; in *maculata* next;

and in *Prodoxus decipiens* very much smaller. To be more explicit I reproduce from the article referred to the following descriptive details:

If we examine the internal anatomy, we find that the ovaries are large and pyriform, composed of four multilocular tubes gradually enlarging to the point of insertion in the oviducts and with the opposite extremity prolonged into a binding cord attached to the thorax. The oviducts are rather short. There are two large sebaceous glands and two smaller accessory glands, and a large copulatory pouch connected with the oviduct by a short tube or canal which opens close to the entrance of the ductus seminalis, this leading to the receptaculum seminis. This receptaculum is nearly as large as the bursa, pyriform, flattened dorso-ventrally when empty, but more rounded when filled with semen. Its chief characteristic, however, is a pair of curious brown radiate bodies, the rays or spicules springing from a central hub, which looks like the disc of a composite flower. These bodies are attached at opposite sides of the pyriform sac and are so large and conspicuous as to be readily seen through the walls of the abdomen when this is mounted in balsam. The hub is concave from the outside and convex from the interior, the disc presenting a granulated structure and the spicules radiating from its margin obliquely into the interior of the sac. Each spicule, when closely examined, is seen to have along its inner border a hollow groove running from the base to the extreme tip (Fig. 13 *d*). There are some seventy or more of the longer

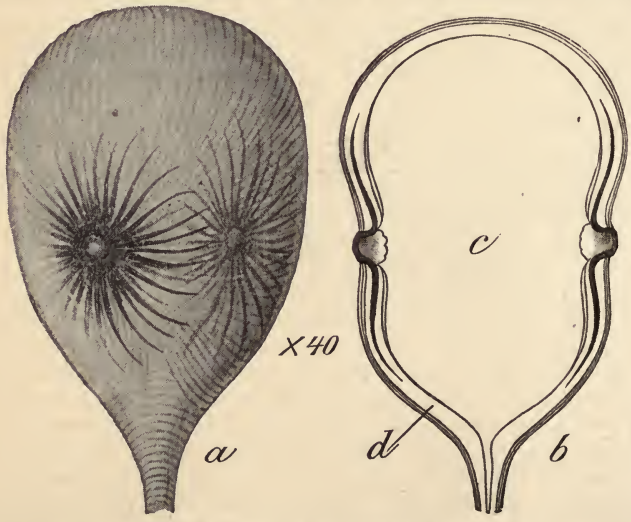

Fig. 13.—*a*, receptaculum seminis of *Pronuba yuccasella*, showing radiate bodies or crushers and muscular structure; *b*, same, longitudinal section through axle of hub, showing the main sac and the inner sac at *c* and the radiate bodies in the intervening space at *d* — × 40.

spicules and other shorter ones; but they vary less in length than in other species. In the impregnated female there is found within this receptaculum, and almost filling it, what appears to be an inner sac with a narrow neck entering and following the neck of the receptaculum. This is doubtless but a combined mass of spermatic particles or fasciculi forming what has been called by Lepidopterists the large spermatophore. The albumen-like wall or envelope of this mass is somewhat thickened as it approaches the hubs of the receptaculum but then suddenly becomes thin and is somewhat insecurely fastened to the hubs, so that when the spermatophore is detached there is practically an opening in each side at the point where it was attached to the receptaculum. There are three membranes to this receptaculum—an external or muscular, a middle or serous, and an internal or mucous. The strong fibres of the muscular coat radiate from the border of the hub of one of the chitinous bodies, and are inserted in a similar position upon that of the opposite side. They thus include the whole of the sac until toward the neck, where they change to circular constricting fibres, and thus continue through the duct. Fig. 13 *a* gives an enlarged view of this receptaculum, with a longitudinal section through the hubs at *b*, showing the large spermatophore or inner sac *c*, the space between it and the walls of the receptaculum, and the manner in which the hub and the radiate spicules are placed at *d*. In *Pronuba yuccasella* this receptaculum averages about 1.7 mm. in length, by 1 mm. in diameter, the crusher or radiate body measuring 1 mm., the rays averaging 0.43 mm. in length and the hub or axis 0.14 mm. in diameter. By way of exhibiting how very much more strongly developed this receptaculum and its crushers are in *yuccasella* than those in any other species, I have introduced (Fig. 14) drawings of the similar organs of *Pronuba synthetica* (*a*), *P. maculata*

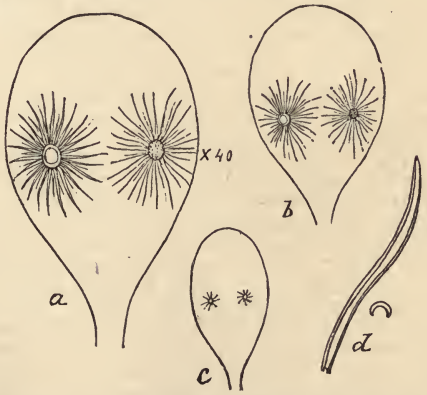

Fig. 14.—*a*, outline of receptaculum seminis of *Pronuba synthetica*; *b*, do. of *Pronuba maculata*; *c*, do. of *Prodoxus decipiens*, all drawn to same scale as figure 13; *d*, enlarged spicule showing ventral groove and a transverse section of same.

(*b*), and *Prodoxus decipiens* (*c*), drawn to the same scale. In *P. synthetica* the receptaculum averages about 1 mm. in length and 0.66 in width; the crusher has a diameter of 0.43 mm., the longer rays about 0.17 mm. in length, and the axis or hub about 0.10 mm. in diameter. The crusher in this species looks much more like a burr, there being 16 of the longer, 24 of a shorter size, 32 yet shorter, and a number of the shortest which graduate into the tubercular inner surface of the hub. In *P. maculata* the receptaculum has a length of 0.66 mm., and a diameter of 0.5 mm.; the crusher has a diameter of 0.4 mm., the longest rays a length of about 0.17 mm., and the axis a diameter of 0.06 mm. In *Prodoxus decipiens* the receptaculum has a length of 0.65 mm. and a diameter of 0.3 mm. The crusher measures 0.09 mm., with the longest rays 0.05 in length and axis 0.02 in diameter. The axis is relatively longer than in the other species, and the spicules are much reduced in number.

The object of these chitinous bodies has been somewhat of a puzzle, all the more difficult to solve that they seem to be quite exceptional, and, in the remarkable development which they here present, absolutely unique, so far as I have been able to ascertain. They attracted my attention in my earlier studies of Pronuba and I was glad to find, on visiting Dr. H. A. Hagen in 1880, that he had been very much interested, in his studies of Prodoxus, in the similar but smaller organs of that insect. His explanation of their function, as elaborated in the Zoologischer Anzeiger (Jan. 1882, pp. 18–21), is doubtless correct, viz., that they serve to liberate the spermatozoa from the spermatophores, but he was in error in locating them in the bursa instead of the receptaculum.* The muscular arrangement which I have described is well suited to such a purpose. In the somewhat flattened receptaculum the spicular arms actually intermingle, and the radiating muscular coat possesses the only arrangement of fibres which would enable a simple contraction to bring at once the whole con-

* In this paper Dr. Hagen elaborately describes these radiate bodies from both Pronuba and Prodoxus. Aside from the error of locating them in the *bursa* instead of the *receptaculum*, some of his other statements are very confusing in the light of the facts as observed by me. What he calls the inner sac (the large spermatophore) does not occur in the virgin but only in the impregnated female, and yet he describes it from what he insists were virgins, stating that "die drei ersten Schmetterlinge welche auskamen waren Weibchen; da ich sie untersuchte bevor einige Tage später Männchen erschienen, bin ich sicher das sie unbefruchtet waren." He then states that he found the empty space between the inner sac and the inner lining of the outer sac filled, after coition, with spermatophores clustering particularly about the star, while the inner sac and its outlet contained only the hair-like spermatozoa. I cannot explain the earlier statement except as another of the unfortunate errors my good friend has been led into in connection with the Yucca moths. It is so explicit, however, that, since this communication was presented, I have again examined virgin females of both Prodoxus and Pronuba, only to confirm the fact that there is no inner sac to the receptaculum, and that the presence of this sac or large spermatophore is a sure evidence of impregnation.

tents of the sac into the nest of pointed blades. At the same time an egress is afforded the liberated spermatozoa through the mouth of the duct—the only point not constricted by the radiating fibres—and once within its walls a successive contraction of its muscular fibres, like the vermicular action in the small intestines of mammals, would cause their ready descent to the oviduct. Thus the spicules not only serve to liberate the spermatozoa, but also to facilitate their egress through the attached base, where the spermatophore wall is thinnest.

2.—Pseudo-cenchri.

A feature which in *Pronuba synthetica* tends to add to its saw-fly resemblances is a pair of cenchri-like spots on the metathorax which are transversely ovoid and more or less iridescent and translucent, showing the more distinctly by their pale color as compared with the darker piceous coloring of the thorax itself. In denuding a number of specimens in other families of Lepidoptera to see how general these cenchri-like spots are, I have been led to some rather interesting observations.. I find that they are noticeable in other species of the Tineina, but are easily overlooked because the vestiture generally hides them, and further because they are not ordinarily as specialized as in Pronuba. They are superficial and yet with a sufficiently differentiated structure to be quite noticeable, the surface being covered with transparent papillæ which easily rub off. The true cenchri of Hymenoptera seem to be little understood by writers, and, in fact, they have received comparatively little study as to their function. They vary in structure in the different families, so far as the few observations I have made justify a conclusion, but generally consist of a scale which forms a sort of lid to a cavity protected by a membrane and which indicates that they may be organs of sound rather than of any other sense. They occur on the metathorax immediately behind the scutellum in Tenthredinidæ and Uroceridæ, and are generally referred to as light-colored spots, or more minutely—as by André—as "two small symmetrical callosities, usually light and semi-transparent; rarely they are covered, as in Lyda, by a sort of scale or overlapping hood, and their function is not known." They are called granulæ by Thompson, and cenchri by most others.

A closer examination of their structure shows that they are always or very generally in the form of scales, which are free on the posterior end and side, and thus form a hood or projection over an opening into the body cavity. This opening, so far as can be determined in dried specimens, is protected by a delicate membrane.

The scale-like protection of the cenchri, as described from the species of Lyda, is inaccurate, for the scale is the cenchrus, which

in this genus projects or is raised at its free end noticeably from the general surface of the body. In other saw-flies and in Uroceridæ the scale is applied rather closely to the edges of this opening, and in Cimbex and other species fits into a depression so that careful dissection is necessary to show its true character. This scale is usually oval, but in Lyda (and less so in Uroceridæ) is more or less triangular. It is lighter colored than the rest of the body (less so in Uroceridæ and some species of Lyda), is nearly transparent, and is, so far as studied, hexagonally sculptured over its entire surface. It is much thinner than the chitinous wall of the body and generally membraneous. Beneath it is a large open space closed in whole or in part by a muscular band. As I have asked Mr. Marlatt to follow up the subject so far as the Hymenoptera are concerned, and to give us the results at some future meeting, I will not enter into further details in reference to that Order. I will simply add that in the Lepidoptera, in which I have examined the types of a good many families, the similarly placed but superficial spots are not specialized, but are mere inflations or modifications of the chitine wall. They are wanting in the Rhopalocera and in the higher groups of the Heterocera, while in the Tortricina and Tineina, in which they are usually well developed, they have remained unnoticed for the reasons stated above. They are, in fact, structurally quite distinct from the true cenchri of the Hymenoptera and recall them chiefly because of their similar position on the metathorax. Yet it is difficult to overcome the conclusion that the true cenchri of the Hymenoptera are, in some way, modifications of these simple structures in the Lepidoptera. The peculiar opalescence which they often show in the Lepidoptera is caused by the refraction of the light due to thickly placed chitinous papillæ, but so far as I have been able to see there is no modification of the chitine wall and no opening.

3.—The Tegulæ and the Patagia.

In denuding these different species of Lepidoptera of various families I was interested in noting the remarkable variation, and at times the great prominence, of the tegulæ, organs which are usually clothed with special hairs which form the shoulder lappets, and the actual chitinous structure of which is generally overlooked by lepidopterists. I exhibit certain specimens to show how these tegulæ when denuded form prominent tuberculous or scale-like projections, and are the more conspicuous by virtue of the different coloration from the rest of the thorax. The strangest thing about them, however, is that they have been confounded by most authors with the patagia. On the authority of Westwood (Vol. II, page 314) Kirby and Spence were the first to definitely point out and describe the appendages of the prothorax,

which they called patagia. Chrebrier was, however, the first to discover them, though he probably confounded them with the tegulæ. Burmeister entirely overlooks the presence of the patagial appendages of the prothorax, and asserts that the patagia of Kirby and Spence are identical with their tegulæ, which cover the base of the anterior wings (page 78), and his remark (page 77) that the patagia of Kirby and Spence, which they considered as appendages of the prothorax, are not set upon this but upon the mesothorax, indicates his entire failure to observe the true patagia of the prothorax. He adopts also the term patagia for the tegulæ. It seems that from this error a general confusion relating to these appendages has arisen, and a number of lepidopterists have followed Burmeister blindly in confounding the patagia with the true tegulæ, or rather in ignoring the former and applying the term patagia to the tegulæ proper, and this, in spite of the fact that Kirby and Spence had clearly defined the two structures and figured them, and that Westwood had later called attention to the very confusion which lepidopterists had before made and have since continued. Thus Packard in his "Guide" does not describe the patagia, but uses the term for the tegulæ. Minot & Burgess (Fourth Rep. U. S. E. C.) call the true patagia two pendulous lobes which project from the upper sides of the prothorax, the real homology of which is said not to be determined. They follow Packard in calling the tegulæ patagia. J. B. Smith has, in his writings, so far as I can find, omitted all mention of these organs. Mr. C. H. French, in his Butterflies of the Eastern U. S., simply says: "The only appendages of the prothorax are a series of scales arising from the upper side, forming a collar, and on each side a small scaly piece covering the base of the forewings and known as the shoulder tuft, lappet, or pterygoid." He evidently refers here to the tegulæ, which are not attached to the prothorax as stated. W. F. Kirby, in the chapter on butterflies, etc., in Cassell's Natural History, refers to the tegulæ as the scapulæ, and does not mention the patagia. The same author, in his European Butterflies and Moths, does not refer specifically to these parts, but mentions a tuft of scales on the thorax behind the collar. J. H. Comstock uses the term "paraptera" for tegulæ, and calls attention to the various terms that have been used for these "leaf-like epaulets," remarking that in the Lepidoptera they are very large and are usually termed patagia. He falls into the same error as Packard and Minot, and seems to overlook the true patagia on the prothorax. Scudder follows Minot and calls the patagia in butterflies the "prothoracic lobes." The original definitions by Westwood and Kirby and Spence should evidently be our guides in the nomenclature of these parts, viz:

Patagia, concavo-convex scales covered with hairs on the upper side of the prothorax.

Tegulæ (pterogodes of Latreille; paraptera of McLeay; scapulæ of other authors), the triangular scales covering the base of the primaries.

NEW SPECIES OF PRODOXIDÆ.

By C. V. Riley.

Upon my return from California in 1887 I gave some account before the Society of the insects associated with *Yucca brevifolia*, the tree yucca of the Mojave Desert, and exhibited specimens of the Pronuba, which I found to be associated with the flower of the yucca as its pollenizer. I called attention to its peculiarities and suggested that I would describe it by the specific name of *paradoxa*. Pressure of other work has, up to the present time, prevented my doing so, but in connection with an article which I have recently prepared for the Annual Report of the Missouri Botanical Garden I have characterized the different species of Prodoxidæ. As that publication is not purely entomological in character, I have decided to present the descriptions of the new species to this society for publication.

Pronuba synthetica.—Larva (Fig. 15, *a*).—Length when full-grown, 14 mm. Somewhat more cylindrical than that of *yuccasella*, the general color being bluish-green tinted with a rosaceous hue; otherwise undistinguishable from those of the other two species.

Fig. 15.—*Pronuba synthetica: a*, larva from side; *b*, ♀ chrysalis, ventral view; *c*, do., lateral view—nat. size in hair line; *d*, lateral, *e* dorsal view of anal joints of ♂; *f*, *g*, do. of ♀; *h*, dorsal view of 2d and 3d joints of abdomen—all more enlarged.