gracilis, *S. Mantelli*, *S. Phillipsii*, *S. Sillimani*, &c., I have been fortunate enough to discover the following North-German forms:—

Pecopteris Geinitzii,
Pecopteris Murchisoni,
Pterophyllum schaumburgense (*Dunker*).

and an undetermined one, which I think is *Sphenopteris Gœpperti*. They all occur in the beds of stone in the Wadhurst Clay, which are locally used for building and road-metal.

MISCELLANEOUS.

On the Significance of the Polar Cells of Insects.

By M. Balbiani.

There is now scarcely any one who admits the homology of the polar cells of insects with the bodies designated by the same name, or more frequently by that of *direction-vesicles*, in animals of other classes, especially the Mollusca and Vermes. Notwithstanding their extreme resemblance, it is well known that a capital difference exists between these two kinds of elements: the direction-vesicles disappear without taking any part in the formation of the embryo, while the polar cells persist and penetrate into the ovum in course of development. But authors are not agreed as to the part played by these elements in the phenomena of organogeny. The first observers, MM. Robin (1862) and Weismann (1863), supposed that they penetrated into the blastoderm to become confounded with the cells of that membrane; but they could not ascertain what became of them in the subsequent evolution. Alex. Brandt, in 1878, was no more fortunate than his predecessors. Metschnikoff, in 1866, studying the development of the viviparous larvæ of Cecidomyids (*Miastor*), was led to see in the polar cells the rudiments of the organ in which is produced the living progeny by which these Diptera multiply during a great part of their existence. But this observation of the Russian embryologist has remained completely isolated; and moreover the singularity of the phenomena of reproduction in *Miastor* did not authorize the extension of his conclusions to the other animals of the same class. Consequently the significance of the polar cells has remained in much obscurity, and the last author who has paid attention to the question (Weismann) could say in a recent memoir (1882) that there is no reason for modifying the name under which these bodies are known so long as the part they perform in the formation of the embryo is not placed above all uncertainty.

In an insect reproducing by the normal mode of fecundated and deposited ova (*Chironomus*) I have succeeded in tracing the transformations of the polar cells in the whole series of phases of embryonic development, from the moment of their first appearance up to

hatching, and I have thus been able to determine the precise significance of these elements. I shall not describe the manner in which they are formed in *Chironomus*, the facts having been described in detail by MM. Robin and Weismann ; but I am not in agreement with those observers as to the number of polar cells that we meet with in these insects when these bodies are definitively constituted. Weismann makes them as many as twelve ; and, according to M. Robin, their number may even rise to sixteen or twenty by the successive divisions of the polar cells originally formed. I have never found more than eight, in the two species at least of *Chironomus* that I have observed.

The group formed by the eight polar cells is still perfectly isolated and visible at the commencement of the formation of the blastoderm, in the space left at the posterior pole by the vitellus when it has attained the maximum of its retraction. In proportion as the blastoderm becomes organized, the vitellus elongates again towards the two extremities of the egg, and presses against the external envelope the aggregation of polar cells, which is soon completely concealed by the blastoderm ; but these cells do not become at all confounded with those of this germinal membrane, as has been supposed by the observers to whose opinion I have already referred. In fact we soon see a slight impression of the blastoderm produced at the posterior pole, forming, as it were, a fold of that membrane towards the interior of the egg. This invaginated part, or caudal extremity of the embryo, pushes before it the group of polar cells, which collect into a rounded mass and always adhere loosely to each other, by which means they retain their original spherical form.

By the advance of the invagination this mass comes to be placed between the caudal rudiment and the ventral surface of the egg, surrounded on all sides by the granular substance of the vitellus. After arriving in this position the polar cells do not again quit their relations with the caudal extremity, which they follow in all its positions at the different stages of development. We still find them there when this part has become elongated by ascending along the convex or dorsal side of the egg, so as to touch with its extremity the posterior margin of the head. During this ascending movement the polar mass divides into two equal oval portions, placed somewhat obliquely on each side of the longitudinal axis of the tail. To arrive at a more complete idea of the constitution of these secondary masses, it is necessary to isolate them and to submit them to the action of reagents. We then ascertain that each of them is formed of two spherical cells, flattened at their surface of contact. From this it appears that instead of the original eight polar cells we no longer find more than four, probably in consequence of a fusion, two and two, of the eight preexisting cells. The reagents do not reveal any enveloping membrane around each mass ; but they show that its two constituent cells are in course of proliferation, by causing from two to four clear nuclei to appear in the interior of each of them.

At a more advanced period of development the caudal extremity

is brought back, by the contraction of the embryonic band, towards the posterior pole. It is at this moment that the anus and the posterior intestine are formed, by an invagination of the ectoderm at the extremity of the tail. The posterior intestine, as it lengthens, passes between the two polar masses and separates them from each other. Lastly, at the moment of hatching, the larva possessing all its organs well formed, it is easy to appreciate, from the relations and structure of these masses, their significance in the organism. They are situated in the ninth segment of the body, on each side of the digestive tube, at the level of the junction of the posterior with the middle intestine. An epithelial membrane then surrounds each mass and is produced at its two extremities into a slender filament. Finally, in the interior of the mass the nuclei have multiplied. From all these characters it is impossible to mistake that we have to do with the generative organs of the animal. These then, as we hope we have demonstrated, have their origin in the polar cells.

From this mode of development some interesting consequences follow with regard to the general morphology of the reproductive organs. We have first of all their very early formation, preceding that of all the other organs of the embryo, and indeed even that of the embryo itself in its most rudimentary form, the blastoderm. We have then the community of origin, not only of the male and female sexual products, but of these and of the embryo. We may consequently say that the ovule, the spermatozoid, and the embryo have as their common author the fecundated egg; but while the latter is capable of being directly developed, the former two only acquire the aptitude for development by their union in a new fecundation.—*Comptes Rendus*, November 13, 1882, p. 927.

On Turriform Castings of Earthworms in France.

By M. E. L. Trouessart.

The author observed in gardens in the neighbourhood of Angers, along with numerous worm-casts of the ordinary shape, a great quantity of tower-like castings, exactly similar in form and size to that figured by Darwin in his book on earthworms, and ascribed by him to an exotic species of *Perichæta* naturalized in the neighbourhood of Nice.

These turriform worm-casts were about 2 or 3 inches in height, and about $1\frac{1}{5}$ inch in mean diameter; some were more regular than indicated by Darwin, but formed in the same manner, of thick coils of an argillo-calcareous material, black at the moment of production, but becoming light yellowish grey in drying. The earthy matter was strongly agglutinated by a mucus, and resists the rain for a considerable time. All the towers were traversed by a cylindrical passage moulded on the body of the worm, and terminated above in a cone at some millimetres from the apex of the tower. In most