raphy of his many publications. In the volume entitled "Rafinesque, A Sketch of his Life with Bibliography," by Professor T. J. Fitzpatrick, we have placed before us a most readable account of the life of this gifted and eccentric man, who was so tireless a student and observer of nature. To this part of the book fifty pages are given, every page of which is full of interest. Born of French and German ancestry in a suburb of Constantinople in 1783, he lived mostly in France until 1802, when he came to America, remaining several years. Returning to southern Europe for a period, he finally came again to America, where he remained until his death in 1840.

The story of his life is told with absorbing interest and no one can run over these pages without feeling grateful to the writer who has made the eccentric hero of the story live again for us, and we may hope that many who read it will be inclined to think less harshly of his work, done, as it was, in a period when science was little recognized in this country.

The Bibliography will be a revelation to many scientific men who have known about Rafinesque only in a general way. All told the list includes 941 titles. The author says in his introduction that "the writings of Rafinesque are varied and widely scattered," and refers to the difficulty he experienced in collecting the material upon which his list is based. The list consists of titles, dates, places of publication and notes, the latter often very interesting as including historical facts not to be found elsewhere. Here and there one finds a photographic reproduction of a title page, often very quaint and old-fashioned.

After the regular bibliography a few pages are given to a list of 134 articles that refer to Rafinesque, some rather fully, and others only incidentally. The book closes with a short chapter on the portraits of Rafinesque.

One can not turn from a reading of this book of Professor Fitzpatrick's without feeling that in Rafinesque American science had a man of far more than ordinary ability, and that while eccentric and erratic he has still to be reckoned with as one who studied nature and found out many of her secrets, in the early days when naturalists were few and far between. And science owes much to the author and the Historical Department of Iowa for bringing together all this information and issuing it in this very attractive volume.

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SPECIAL ARTICLES

THE HISTORY OF THE GERM CELLS IN THE PÆDOGENETIC LARVA OF MIASTOR

Six years ago, when I began to study the origin of the germ cells in insects, an attempt was made to obtain specimens of the pædogenetic larvæ of certain flies belonging to the family Cecidomyiidæ. At that time I was informed by one of the best authorities on the Diptera that there were none in this country. Since then they have been discovered (October 5, 1910) by Dr. E. P. Felt and many features of their life history have been determined by him.[1] I am indebted to Dr. Felt for an abundant supply of these interesting larvæ, upon which work is now progressing.

As early as 1865 the fact that the germ cells (pole cells) of the pædogenetic Cecidomyiidæ are set aside very early in embryonic development was pointed out by Leuckart[2] and Metschnikoff.[3] Their brief descriptions were followed a year later by a more detailed account.[4] Eggs were found containing only two nuclei which were supposed to result from the division of the germinal vesicle. These nuclei continued to give rise to others by division

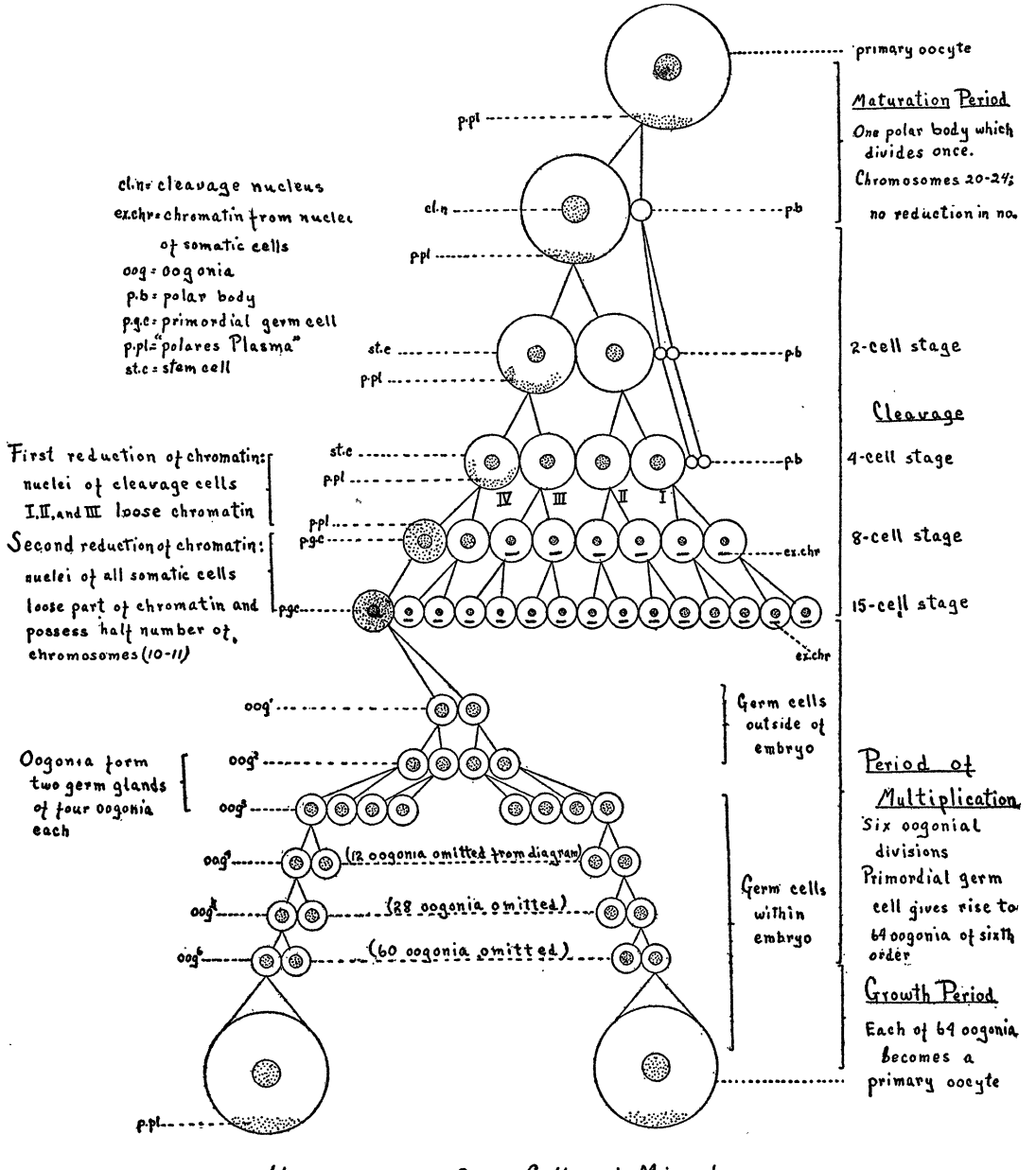
[1] Felt, E. P., "Miastor and Embryology," Science, Vol. 33, pp. 302–303, 1911; "Miastor Americana, Felt; an Account of Pedogenesis," Bul. 147, N. Y. State Museum, pp. 82–104, 1911; "Miastor," *Journ. Ec. Ent.*, Vol. 4, p. 414, 1911.

[2] Leuckart, R., "Die ungeschlechtliche Fortpflanzung der Cecidomyienlarven," *Arch. f. Naturg.*, Bd. 1, 1865.

[3] Metschnikoff, E., "Ueber die Entwicklung der Cecidomyienlarven aus dem Pseudovum," *Arch. f. Naturg.*, Bd. 1, 1865.

[4] Metschnikoff, E., "Embryologische Studien an Insekten," *Zeit. f. Wiss. Zool.*, Bd. 16, 1886.

until twelve to fifteen were produced, one of which, lying at the pointed pole of the pseudovum, became surrounded by a thick, dark yolk mass and with it separated as a distinct membraneless cell, the first pole-cell. This then divided into two and later into four cells. These four then separated into two groups of two cells each and were recognized as the



History of the Germ Cells of Miastor

FIG. 1.

primitive reproductive organs lying in their definitive positions. From 1866 until 1908 nothing was added to our knowledge of the embryonic development of these pædogenetic larvæ. Kahle,[5] however, has given a remarkably clear and detailed account of the subject and I have already been able to confirm many of his results.

The entire "Keimbahn," as described by Kahle, is shown in the accompanying diagram. The primary oocyte contains, at the posterior pole, a mass of protoplasm which stains more deeply in aniline and carmine than does the rest of the material in the egg. This substance is named "polares Plasma." From twenty to twenty-four chromosomes are present. One polar body is given off, and this divides once. One of the eight nuclei resulting from the first three divisions of the egg nucleus becomes embedded in the "polares Plasma" and is cut off by cell walls forming the primordial germ cell. During the division from the 4-cell to the 8-cell stage, three of the nuclei (I., II., III.) lose part of their chromatin, which is cast off into the cytoplasm, and is called by Kahle "Chromatinreste." The next, or 15-cell stage, includes a single primordial germ cell which contains the "polares Plasma" and possesses a large nucleus with the full amount of chromatin, and fourteen somatic cells, each of which lacks "polares Plasma," and has a small nucleus from which part of the chromatin has been cast out, and which possesses only half the number of chromosomes (10–11).

The primordial germ cell undergoes six successive divisions, thus producing sixty-four oogonia of the 6th order. At the end of the third division two germ glands are formed of four cells each. The multiplication period is followed by the growth period during which each oogonium enlarges into a primary oocyte with a nucleus containing from 21–24 chromosomes and with a mass of "polares Plasma" at the posterior pole. The origin of the "polares Plasma" was not discovered.

Miastor americana Felt agrees so far as I have been able to determine with the species studied by Kahle (*Miaster metraloas*). The "polares Plasma" is present; the primordial germ cell is set aside at the 8-cell stage; and two germ glands of four oogonia each are formed. I have not, however, been able to count the chromosomes accurately nor to find division figures of early stages which show the diminution of the chromatin. These stages I hope to find later.

The determination of the germ cells of *Miastor* seems to combine two of the methods that have already been described for other animals. The presence of a deeply staining mass of material at the posterior pole of the egg, which becomes a part of the primordial germ cell but is excluded from the somatic cells, is similar to the condition in Chrysomelid beetles, in *Cyclops,* and in *Sagitta;*[6] whereas the diminution in the amount of chromatin which takes place in the somatic cells but does not occur in the primordial germ cell is like the casting out of the chromatin from the nuclei of the somatic cells of *Ascaris.*[7]

The "Keimbahn" of *Miastor* furnishes a remarkably clear example of the continuity of the germ plasm. It likewise enables us, at least in one instance, to state the number of cell divisions that occur during the period of multiplication of the oogonia, and, indeed, the number of cell divisions from one oocyte to the sixty-four oocytes of the next generation, namely, ten. The writer is now engaged in an attempt to determine the origin of the peculiar substances (germ cell determinants) such as the "polares Plasma" of *Miastor* which have been observed in the primordial germ cells of many species of animals, and hopes to discover the rôle they play in the primary differentiation of germ cells and somatic cells.

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[5] Kahle, W., "Die Paedogenesis der Cecidomyiden," *Zoologica,* Heft 55, pp. 1–80, 1908.

[7] Boveri, Th., "Die Entstehung des Gegensatzes zwischen den Geschlechtszellen und den somatischen Zellen bei *Ascaris megalocephala,*" *Setz. Ges. f. Morph. Physiol.,* Bd. 8, 1892.

[6] Hegner, R. W., "Germ Cell Determinants and their Significance," *Am. Nat.,* Vol. 45, pp. 385–397, 1911.