# DEVELOPMENT IN THE MONOTREMES*

NEARLY a hundred and fifty years have elapsed since the first descriptive account of the Platypus aroused the interest and stimulated the curiosity of the zoologist. Not only did its peculiar external features prompt the name of *Ornithorhynchus paradoxus* proposed for it by Blumenbach, but the general resemblance of its female reproductive organs to those of birds and reptiles rather than to those of mammals suggested its probable oviparous habit.

Very soon, its near congener, Echidna, in spite of its widely different outward appearance, was found to possess the same essential characters. These characters not only led to their classification in the same proposed natural order, Monotremata, but also to their recognition as the only known members of a mammalian sub-class, later named by Huxley Prototheria.

After much conflict of opinion, full scientific confirmation of the fact of oviparity was only finally secured by Caldwell in 1884, and was dramatically announced in a cable message to the British Association of its meeting in Montreal.

Previous to Caldwell's scientific quest, there are no records of the scientific collection of specimens of early embryonic stages of Monotreme development. Even the material described by Caldwell (1887) and by Semon (1894), and that available to Wilson and Hill (1907), was insufficient to reveal more than the outlines of the earliest processes of Prototherian egg development.

The appearance, therefore, of a substantial instalment of their work on Monotreme development by Profs. T. T. Flynn and J. P. Hill (December 1939) is to be warmly welcomed. That work is based upon a relatively rich collection of rare material accumulated by the authors over a period of many years. The present memoir deals with the earliest phases of development of the ovum in both Ornithorhynchus and Echidna, and includes a description of the processes of oogenesis, maturation, fertilization and early cleavage.

Following a brief account of the breeding season and of ovulation in Echidna, a description is given of the intrauterine egg, and then of the laid (pouch) egg in that species. In the great majority of cases one egg only is brought forth, whilst in Ornithorhynchus, as a rule, twin eggs are produced and the shells of these are usually adherent to each other. In Echidna both ovaries are equally productive, while in Ornithorhynchus the left ovary alone is functional.

*Oogenesis.* The structure and growth of the ovarian oocyte are followed in detail through a series of phases. In the first phase the differentiation of the cytoplasm into peripheral and central zones is visible. The zona pellucida originates as a product of the ovarian follicular cells; a later distinct "striate layer" within the zona may either have a like origin or be formed from the oocyte itself. During the succeeding phase the zona is well established and the origin of yolk-sphere primordia in the cortical cytoplasmic zone can be recognized. During the next phase, active formation of definitive yolk-spheres sets in, at first from the periphery inwards, in the cortical cytoplasm: with the establishment of a typical latebral yolk-zone the formation of definitive yolk-spheres progresses from the latter zone in an outward, peripheral direction. This yolk-forming function of the latebra is discussed at some length together with the corresponding phenomena of the avian egg.

The authors confirm Caldwell's observation of the layer enveloping the oocyte named by him the "pro-albumen" layer, but they reject his interpretation of it as a precursor of the definitive egg-albumen of later stages. They show it to be a secretion of the follicular cells and regard it as the homologue of the liquor folliculi of the Graafian follicule of other mammals.

On the question of the origin and nature of the true albuminous and other constituents of the secondary egg envelopes, which are formed during passage of the ovum through oviduct and uterus, the observations of Dr. C. J. Hill are cited and confirmed.

*Maturation.* In both Monotremes this appears to be typical: the formation of each of the two polar bodies is illustrated in a series of remarkable figures on plates XIII and XIV. It is noteworthy that the second polar body—given off within the oviduct—was apparently formed independently of fertilization.

*Fertilization.* Until completion of maturation the germinal disk remains circular, but with the occurrence of fertilization a definite bilateral symmetry is established in the now elliptical area. Towards one end of the longer axis of the area the germinal disk is richer in its content of fine yolk-spheres than at the other, and the conjugating pronuclei lie nearer to the yolk-rich end of the axis.

Conjugation of the pronuclei is fully illustrated in the fine series of figures (74–83). Polyspermy does not normally occur in the Monotremes, although it would appear to be the rule among the Sauropsida.

*Early Cleavage.* The remainder of the memoir deals in detail with the phenomena of early blastomeric segmentation, the pattern for which is, of course, typically meroblastic.

The first cleavage furrow is transverse to the long axis of the elliptical germinal disk, that is, to the axis of bilateral symmetry. It subdivides the disk into two somewhat unequal areas, of which the smaller is markedly richer in yolk-sphere content. The two areas resulting from the first cleavage are thus dissimilar both quantitatively and qualitatively. The second cleavage is approximately at right angles to the first and coincident with the long axis of the germinal area. The third furrows are more or less parallel to the first and the result is "an eight-celled stage consisting of two linear aggregates each of four cells, symmetrically arranged on each side of the long axis of the disc, i.e., of the second cleavage furrow".

After the 16-cell stage, the arrangement of the blastomeric segments tends to become irregular, but shows a striking resemblance to the Sauropsidan pattern.

Although the bilateral symmetry of the pattern in the eight-cell stage is so evident, the authors do not consider it possible to determine, in the Monotreme, the relationship of the long axis of the unsegmented disk to the polarity of the embryo.

* "The Development of the Monotremata. Part IV. Growth of the Ovarian Ovum, Maturation, Fertilisation, and Early Cleavage." By Prof. T. Thomson Flynn and Prof. J. P. Hill. *Trans. Zool. Soc., London*, 24, Part 6 (December 1939).

Plates XVII–XXI of the memoir provide ample and brilliant illustration, both in surface and sectional view, of the earlier stages of blastomeric segmentation in the Prototheria, and lead one to anticipate eagerly the authors' future elucidation of the succeeding stages of development and above all of the beginnings of germ-layer differentiation.

Only those with some experience of the technical difficulties involved in the collection, preparation and sectioning of material at once both rare and refractory to treatment can fully appreciate the success with which those difficulties have been surmounted, as well as the excellence of the figures with which the memoir is so abundantly adorned.

## UPWARD MOVEMENT OF SALT IN THE PLANT

Prof. D. R. Hoagland, T. C. Broyer and P. R. Stout of the University of California, Berkeley, read a paper dealing with the upward movement of salt in the plant, with special reference to the metabolic activities of roots, before the U.S. National Academy of Sciences at its annual meeting held during April 22–23.

Previous investigation has proved that accumulation of salt by the plant from the nutrient medium depends on aerobic metabolism of root cells. The relation of root activities in salt accumulation to movement of salt to the shoot has now been studied from several points of view. For certain purposes it has been necessary to conduct experiments over short periods of time with tracer elements, not initially present in the plant. Bromide ions and salts of the radioactive isotopes of bromine, sodium, phosphorus and potassium have been utilized. One of the authors (P. R. Stout) has developed technique for showing in graphic manner the general distribution of radioactivity in the plant by effects produced on X-ray films.

Several general cases of salt movement are recognized: (*a*) under influence of root pressure, (*b*) as affected by transpiration, (*c*) movement under conditions conducive to root injury produced by high salt (for example, sodium chloride) concentrations. Xylem exudates may build up very rapidly concentrations of salt much higher than those of the external solution. This may occur even before the roots have attained their maximum capacity for salt accumulation. The phenomenon is related to oxygen supply to roots, concentrations and kind of salt supplied, and indirectly to photosynthesis. Soluble organic nitrogen compounds and organic acid can also move in the exudate dependent on metabolic activities of the root and nature of salt supplied. The effects of $KHCO_3$ are particularly interesting in connexion with organic acid metabolism. Young active barley plants may absorb and translocate nutrient ions almost as readily in the dark as in the light, over brief experimental periods. Such plants may grow normally for some time with nutrients supplied only during the diurnal dark periods. With large plants, or those less capable of developing root pressure, rapid upward movement of salt depends on transpiration, which may thus indirectly influence absorption of salt by the root. Further evidence was obtained on the path and rate of upward and downward movement of phosphate by the use of radioactive phosphorus.



## REPORTS AND OTHER PUBLICATIONS

*(not included in the monthly Books Supplement)*

### Great Britain and Ireland

Memoirs of the Cotton Research Station, Trinidad. Series A: Genetics. No. 16: (a) The Genetic Interpretation of Plant Breeding Problems, by J. B. Hutchinson; (b) Inheritance of Quantitative Characters and Plant Breeding, by V. G. Panse. Pp. 34. (London: Empire Cotton Growing Corporation.) 2*s.* 6*d.* [138

Medical Research Council: Committee on Traumatic Shock and on Blood Transfusion. M.R.C. War Memorandum No. 1: The Treatment of Wound Shock. (Instructions produced in co-operation with the Army Medical Service.) Pp. ii+20. (London: H.M. Stationery Office.) 4*d.* net. [218

### Other Countries

Report of the Forest Department of British Honduras for the Year 1939. Pp. 22. (Belize: Forest Department.) [158

U.S. Department of Agriculture. Technical Bulletin No. 711: Economic Status of the English Sparrow in the United States. By E. R. Kalmbach. Pp. 66+3 plates. 15 cents. Technical Bulletin No. 723: Biology of the Seed-Corn Maggot in the Coastal Plain of the South Atlantic States. By W. J. Reid, Jr. Pp. 44. 10 cents. (Washington, D.C.: Government Printing Office.) [168

Field Museum of Natural History. Anthropology Leaflet 34: Ancient Seals of the Near East. By Richard A. Martin. Pp. 46. (Chicago: Field Museum of Natural History.) 25 cents. [198

Imperial College of Tropical Agriculture. Ninth Annual Report on Cacao Research, 1939. Pp. 52. (Trinidad: Imperial College of Tropical Agriculture.) 5*s.* [198

Bernice P. Bishop Museum. Bulletin 160: Ethnology of Easter Island. By Alfred Métraux. Pp. vii+432+7 plates. Bulletin 165: Zonitid Snails from Pacific Islands, Part 2: Hawaiian Genera of *Microcystinae*. By H. Burrington Baker. Pp. iii+105–202+plates 21–42. Bulletin 167: Report of the Director for 1939. By Peter H. Buck (Te Rangi Hiroa). Pp. 42. (Honolulu: Bernice P. Bishop Museum.) [198

Occasional Papers of Bernice P. Bishop Museum. Vol. 15, No. 15: Four New Microcryptorhynchus from the New Hebrides and Caroline Islands (Coleoptera, Curculionidae). By Elwood C. Zimmerman. Pp. 167–174. Vol. 15, No. 16: A New Variety of *Ruppia maritima* (Ruppiaceae) from the Tropical Pacific. By Harold St. John and F. Raymond Fosberg. Pp. 175–178. Vol. 15, No. 17: Additional Notes on the Archaeology of Fanning Island. By Kenneth P. Emory. Pp. 179–190. Vol. 15, No. 18: Scolytidae and Platypodidae of the Mangarevan Expedition. By C. F. C. Beeson. (Mangarevan Expedition, Publication 30.) Pp. 191–204. Vol. 15, No. 19: Notes on the Morphology and Sexuality of the Terrestrial Nemertean, *Geonemertes palaensis*. By W. R. Coe. (Micronesian Expedition, Publication 4.) Pp. 205–212. Vol. 15, No. 20: Notes on Micronesian Rubiaceae. By F. R. Fosberg. (Micronesian Expedition, Publication 3.) Pp. 213–226. Vol. 15, No. 21: The Genus *Ficus* (Moraceae) in Southeastern Polynesia. By V. S. Summerhayes. (Mangarevan Expedition, Publication 33.) Pp. 227–228. Vol. 15, No. 22: Hawaiian Plants named by Endlicher in 1836. By Harold St. John. (Hawaiian Plant Studies. 8.) Pp. 229–238. Vol. 15, No. 23: Some New Species of *Araucaricola* Lea from the South Pacific (Coleoptera, Tenebrionidae). By K. G. Blair. Pp. 239–242. Vol. 15, No. 24: Thysanoptera from New Guinea and New Britain. By Dudley Moulton. Pp. 243–270. Vol. 15, No. 25: Synopsis of the Genera of Hawaiian Cossoninae, with Notes on their Origin and Distribution (Coleoptera, Curculionidae). By Elwood C. Zimmerman. Pp. 271–294. Vol. 15, No. 26: The Isopod Crustacea of the Hawaiian Islands (Chelifera and Valvifera). By Milton A. Miller. Pp. 295–322. Vol. 15, No. 27: Mosses of Southeastern Polynesia. By Edwin B. Bartram. (Mangarevan Expedition, Publication 34.) Pp. 323–350. (Honolulu: Bernice P. Bishop Museum.) [198

Tanganyika Territory: Department of Agriculture. Fifth Annual Report of the Coffee Research and Experiment Station, Lyamungu, Moshi, 1938. Pp. 40. (Dar es Salaam: Government Printer.) 1*s.* 6*d.* [208

U.S. Office of Education: Federal Security Agency. Bulletin 1940, No. 4, Part 1: Elementary Education—What is It? By Helen K. Mackintosh. Pp. v+31. (Washington, D.C.: Government Printing Office.) 10 cents. [218