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Preface to Platypus biology: recent advances and reviews. A Theme published by the Royal Society of London

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Phil. Trans. R. Soc. Lond. B 1998 **353**, 1059-1061
doi: 10.1098/rstb.1998.0265

Preface

PLATYPUS RESEARCH 1798–1998

Two hundred years ago the platypus was brought to the notice of European biologists by Captain John Hunter R.N., the governor of the penal colony at Sydney, who sent a skin of the animal to the Literary and Philosophical Society of Newcastle-upon-Tyne of which he was a member. In a letter announcing its despatch, dated at Sydney 10th August 1798, he explained why only a skin was sent: 'The Weather having been exceedling Warm when this Animal was killed, it could not be kept until we could have had an opportunity of preserving it in Spirits, I have therefore sent its skin.' He described it as a 'small Amphibious Animal of the Mole KIND which boroughs in the Banks of the Fresh Water Lakes', and included a drawing of what it looked like in life. An engraving of this was reproduced by David Collins (1802) using Hunter's description in the legend (plate I, figure 1), but with his own spelling of *Ornithorhynchus*!

At the time of despatch of the Newcastle skin, Hunter sent another to Sir Joseph Banks (Goddard 1929), which ultimately landed on George Shaw's bench at the British Museum. The latter published a description of this 'imperfect' specimen in 1799 (Shaw 1799), but the first descriptions of intact monotremes were given by Sir Everard Home in two papers published in the Philosophical Transactions of the Royal Society for the year 1802 (Home 1802*a*,*b*). In these studies Home set the agenda for much of our future platypus research: he recognized that both sexes are cloacate, the males being testicond, and that the expanded proximal parts of the female's oviducts were very similar to the uteri of 'ovi-viviparous' lizards; that the middle ear is entirely mammalian, in that it has malleus, incus and stapes: that the pectoral and pelvic girdles have interclavicle and epipubic bones, respectively; and above all, he noted of the trigeminal nerves that 'the fifth pair which supplies the muscles of the face, are uncommonly large. We should be led by this circumstance to believe that the sensibility of the different parts of the bill is very great, and therefore that it answers the purpose of a hand, and is capable of nice discrimination in its feeling'.

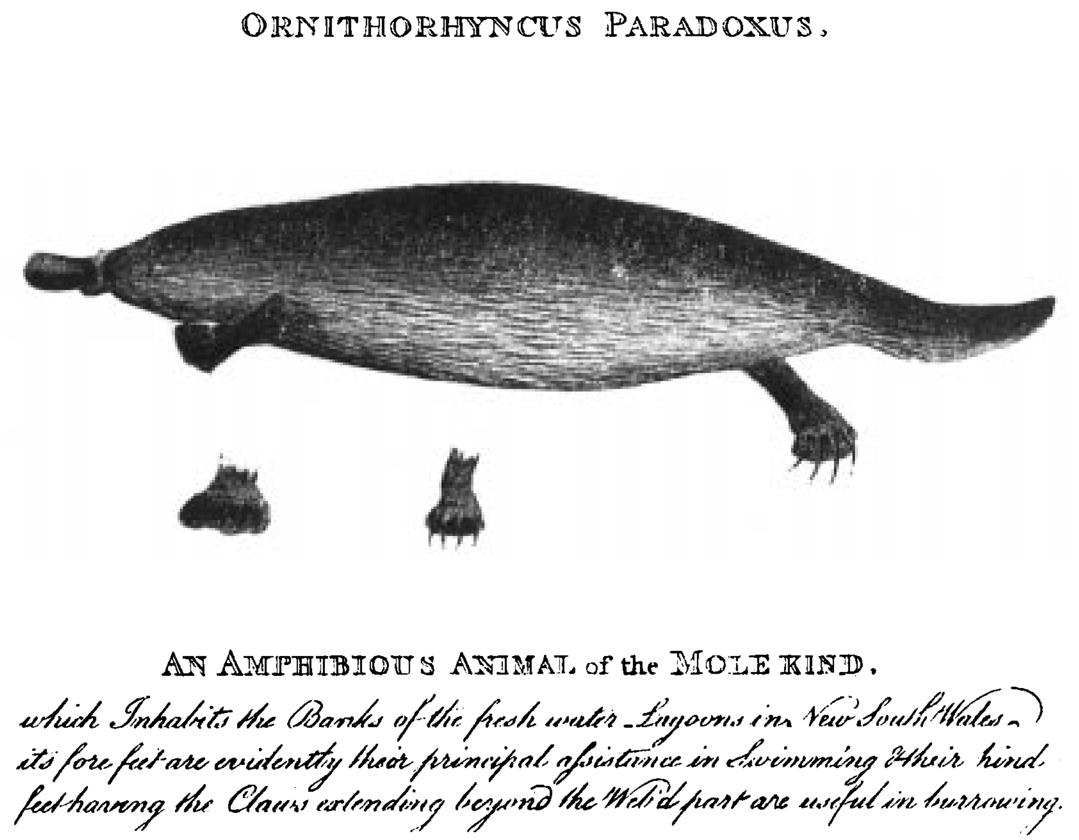

Figure 1. An engraving of a drawing of a platypus made by John Hunter. From Collins (1802).

PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY B BIOLOGICAL SCIENCES

He failed to find mammary glands due to poor preservation of his specimens, but 24 years later Ioanne Friderico Meckelio (alias J. F. Meckel) in his magnificent, *Ornithorhynchi paradoxi descriptio anatomica* (1826), described a pair of enormous ventrally located glands as mammary glands. This interpretation was proved beyond doubt when it was reported in the Philosophical Transactions 1832 that Lieutenant the Hon. Lauderdale Maule of the 39th Regiment, then stationed near Bathurst, had observed milk oozing from the mammary glands of an accidentally killed platypus that had been rearing two young (Maule 1832; Owen 1832).

Fifty-five years after this, W. H. Caldwell published in the Philosophical Transactions for the year 1887, proof that the platypus is oviparous, that cleavage of the ovum is meroblastic and that uterine secretions are the source of nourishment of the developing embryo, as happens during the development of Marsupialia (Caldwell 1887).

Since these all-important aspects of platypus biological development have appeared in the Philosophical Transactions of the Royal Society over the years, it is most appropriate that this assembly of 13 papers on various aspects of platypus research should appear here. Especially so since those on the functions of the bill stem from Home's observations. His 'nice discrimination' has been shown here to be effective at precisely defined distances in the water, by the integrated activation of electro- and mechanoreceptors located in the bill, for detection of prey.

The paper by Siegel *et al.* (this issue) showing REM sleep in the platypus may also be said to stem from early observations: George Bennett (1835) kept two nestling platypuses for some weeks, and during that time he noted that when they were asleep they often appeared to be dreaming of swimming 'their forepaws in movement as if in the act'. Juvenile platypuses would, therefore, seem to be ideal subjects for the study of REM sleep in monotremes, rather than the adult, possibly elderly, echidnas I supplied for Allison *et al.* (1972) whose research results proved to be negative. This present paper dispels that notion that monotremes do not have REM sleep: in fact the platypus have more REM sleep than is known in any other amniote, be it reptile, bird or mammal. Other factors that favour the use of juvenile platypuses are that they are easily caught in the water in February and that they go to sleep readily.

Two papers in the collection are from disciplines new to platypus research: palaeontology, and relationships based on DNA. Palaeontology took a bow in 1975 with the description of the teeth of an Oligocene–Miocene platypus, *Obdurodon insignis*, by Woodburne & Tedford. Some years later a near-perfectly preserved skull of another species of *Obdurodon* was described under the name of *O. dicksoni* (Archer *et al.* 1992). This specimen is the subject of further discussion of the evolution of monotremes by Anne Musser & Mike Archer (this issue), enhanced by Anne's very beautiful illustrations worthy of a place beside those of Meckelio's *Descriptio anatomica*, and of Richard Semon's (1994*a*,*b*) *Forschungsreisen in Australien und dem Malayischen Archipel*.

The other newcomer took the stage in 1994 with Gemmell & Westerman's study of relationships of the platypus within the Class Mammalia, using mitochondrial 12S RNA sequences. Quite recently, Janke *et al.* (1997) also compared the mitochondrial genomes of platypuses, marsupials and eutherians, and as a consequence, resurrected Gregory's (1947) Marsupionta, a taxon that links monotremes and some marsupials together, to the exclusion of Eutheria. John Kirsch & Gregory Mayer (this issue) agree that there is a special marsupial–monotreme relationship, deduced from DNA hybridization data on various mammals including platypuses and echidna, but that their scholarly detailed analysis by no means offers unqualified support for Gregory's concept of Marsupionta. As a spin-off from the data of Gemmell & Westerman (1994) and of Kirsch & Mayer, there is agreement that a monotreme gave rise to Tachyglossidae and Ornithorhynchidae some 25–30 Ma. Evidence that a skull of a fully differentiated echidna (Woodburne *et al.* 1985), and that of *Obdurodon dicksoni*, are of Middle Miocene age is not inconsistent with that date. However, calculations based on amino-acid sequences of globins and α-lactalbumins, indicate that the divergence took place long before that date, perhaps 54 Ma.

It may be mentioned here that although the platypus has been known to us for more than 200 years, we know very little of what happens down John Hunter's 'boroughs'. It is here that the female, in pitch darkness, incubates her eggs and periodically suckles her young for at least four months, during which time the young grows from a putative 400 mg to 600 g. What actually goes on down there we still have to learn.

My best thanks to Ederic Slater for providing a copy of John Hunter's letter to the Literary and Philosophical Society of Newcastle-upon-Tyne

February 1998 Mervyn Griffiths

BIOLOGICAL SCIENCES THE ROYAL SOCIETY B PHILOSOPHICAL TRANSACTIONS OF

References

Allison, T., Van Twyver, H. & Goff, W. R. 1972 Electophysiological studies of the echidna *Tachyglossus aculeatus*. I. Waking and sleep. *Arch. Ital. Biol.* **110**, 145–184.

Archer, M., Jenkins, F. A. Jr, Hand, S. J., Murray, P. & Godhelp, H. 1992 Description of the skull and non-vestigial dentition of a Miocene platypus *Obdurodon dicksoni* n. sp. from Riversleigh, Australia, and the problem of montreme origins. In *Platypus and echidnas* (ed. M. L. Augee), pp. 15–27. Sydney: Royal Zoological Society of New South Wales.

Bennett, G. 1835 Notes on the natural history and habitats of the *Ornithorhynchus paradoxus* Blum. *Trans. Zool. Soc. Lond.* **1**, 229–258.

Caldwell, W. H. 1887 The embryology of Monotremata and Marsupialia. I. *Phil. Trans. R. Soc. Lond.* B **178**, 463–486.

Collins, D. 1802 *An account of the English Colony in New South Wales*. London: T. Cadell Jr and W. Davies in the Strand.

Gemmell, N. J. & Westerman, M. 1994 Phylogenetic relationships within the class Mammalia; a study using mitochondrial 12S RNA sequences. *J. Mamm. Evol.* **2**, 3–23.

Goddard, T. R. 1929 *History of the Natural History Society of Northumberland, Durham, and Newcastle-upon-Tyne 1829–1929*. Newcastle-upon-Tyne: Andrew Reid & Co. Ltd.

Gregory, W. K. 1947 The monotremes and the palympsest theory. *Bull. Am. Mus. Nat. Hist.* **88**, 7–52.

Home, E. 1802*a* A description of the anatomy of the *Ornithorhynchus paradoxus*. *Phil. Trans. R. Soc. Lond.* **92**, 67–84.

Home, E. 1802*b* Description of the anatomy of the *Ornithorhynchus hystrix*. *Phil. Trans. R. Soc. Lond.* **92**, 348–364.

Janke, A., Xu, X. & Arnason, V. 1997 The complete mitochondrial genome of the wallaroo (*Macropus robustus*) and the phylogenetic relationship amongst Monotremata, Marsupialia and Eutheria. *Proc. Natn. Acad. Sci. USA* **94**, 1276–1281.

Maule, L. 1832 Letter quoted by Richard Owen. *Phil. Trans. R. Soc. Lond.* B **1832**, 533–534.

Meckelio, I. F. 1826 *Ornithorhynchi paradoxi descriptuo anatomica*. Leipzig: Gerhardum Fleischerum.

Owen, R. 1832 XXII. On the mammary glands of the *Ornithorhynchus paradoxus*. *Phil. Trans R. Soc. Lond.* B **122**, 517–538.

Semon, R. 1894*a* Die Embryonalhüllen der Monotremen und Marsupialier. *Denkschrif. Med. Naturwiss. Ges. Jena* **5**, 19–58.

Semon, R. 1894*b* Zur Entwickelungsgeschichte der Monotremen. *Denkschrif. Med. Naturwiss. Ges. Jena* **5**, 61–74.

Shaw, G. 1799 The duck-billed platypus. In *The naturalists' miscellany*, vol. 10. London.

Woodburne, M. O. & Tedford, R. H. 1975 The first tertiary monotreme from Australia. *Am. Mus. Novitates*. **2588**, 1–11.

Woodburne, M. O., Tedford, R. H., Archer, M., Turnbull, W. D., Plane, M. D. & Lundelius, E. L. 1985 Biochronology of the continental mammal record of Australia and New Guinea. *Spec. Publ. South Australia Dept Mines & Energy* **5**, 347–363.

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