

https://dspace.org/

Eruption of primary teeth in South Africans from one year of age

Hargreaves, J.A.; Cleaton-Jones, P.E.; Fatti, L.P.; Roberts, G.J.; Hargreaves, V

1997-02

http://hdl.handle.net/10539/19189

Hargreaves, J. A., Cleaton-Jones, P. E., Fatti, L. P., et al. 1997. Eruption of primary teeth in South Africans from one year of age. South African journal of science; 93:81-84

Downloaded from a DSpace repository. https://dspace.org/

Eruption of primary teeth in South Africans from one year of age

J.A. Hargreaves[1], P.E. Cleaton-Jones[2*], L.P. Fatti[3], G.J. Roberts[4] and V. Hargreaves[5]

[1]Faculty of Medicine and Oral Health Sciences, University of Alberta, Edmonton, Canada T6G 2N8; [2*]MRC/University of the Witwatersrand Dental Research Institute, Private Bag 3, WITS, 2050 South Africa (e-mail: 078pec@cosmos.wits.ac.za); [3]Department of Statistics and Actuarial Science, University of the Witwatersrand, Johannesburg; [4]Department of Children's Dentistry, Eastman Dental Hospital, London, UK; [5]Edmonton, Canada.

Erupted primary teeth were recorded in 1 446 South African children from five communities. The data were grouped into 3-month age bands and subjected to Probit analysis.[24] Eruption times were similar in boys and girls. Apart from children of Indian descent having significantly fewer incisor teeth erupted at one year compared to the four other groups, there were no significant differences in canine and molar eruption times among the children. This paper defines primary tooth eruption ages in South African children for anthropological, clinical and forensic use.

Tooth eruption influences the survival of many species but, in spite of scientific enquiry since 1778, there is no consensus on the mechanisms involved.[1] Whatever the mechanisms that produce eruption, it is necessary to know the timing of eruption for anthropological,[2] clinical,[3] and forensic reasons.[4] The eruption of permanent teeth has been widely studied; primary tooth eruption has been investigated less.[5] What has been done covers a spectrum of races, countries, socio-economic status and nutrition.[6–22]

In earlier studies we established eruption times for permanent teeth among South African black children[23] and children of Indian extraction.[24] In these investigations we showed statistically significant effects for gender and race. Black children's first permanent molars and incisors erupted some 3.5 to six months earlier than their compatriots of Indian descent, while these teeth erupted from one to six months earlier in girls than in boys. Regarding the primary dentition, Lavelle[25] showed that these teeth erupted earlier among British Negro children than their Caucasian compatriots. In the United States, Infante[26] reported boys to display earlier eruption of incisor teeth and girls to show earlier eruption of molar teeth.

We wondered what the pattern of primary tooth eruption in South African children of different ethnic groups was but could find no information on this. The present study was therefore undertaken to compare primary tooth eruption in five South African groups.

Materials and methods

The sample studied comprised 1 446 children, aged 1 to 4 years at last birthday, participating in dental caries epidemiology studies which had been approved by the Committee for Research on Human Subjects of the University of the Witwatersrand. There were five study groups, one rural black group living in the Gelukspan district about 350 km west of Johannesburg (0.13–0.20 ppm F in drinking water); and four urban groups (black, Indian and white) living in Johannesburg (including Soweto and Lenasia), with 0.20–0.33 ppm F in drinking water.

In each study area, random samples of birth records were drawn from public health well child clinics; parents were requested to present their children for examination at specified centres. Using good natural light and a dental mirror, each child's mouth was examined for the presence of primary teeth. If any part of a tooth was visible it was considered erupted; likewise, if any tooth had been extracted it was recorded as erupted. At the time of examination, gender, ethnic group,[27] date of birth and date of examination were recorded. Accurate birthdays were available for all children.

The children were grouped into 3-month age bands and the data were subjected to Probit analysis[28] using the Statistical Analysis System[29] to obtain the distribution of the age of eruption for each tooth. Probit analysis deals with the proportion of erupted teeth at different ages and fits a statistical curve based on the cumulative normal distribution. From this curve the mean age of tooth eruption and the standard deviation are determined. Statistical analysis for the effects of jaw side, gender and ethnic group used the chi-squared test and linear logistic analysis with a critical level of statistical significance of $P < 0.05$.

Results

The number and age distribution of the children studied are listed in Table 1. The gender distribution was approximately equal in each group except that girls were slightly more numerous in the white group.

Because no children less than one year of age were seen, Probit analysis for the incisor teeth could not be done. Instead, the numbers of teeth erupted at one year were examined. Table 2 shows the percentage of primary teeth erupted at one year by gender and ethnic group. The numbers of children in each group are not shown because these would clutter the table but the smallest in any gender subset was 26 and the largest was 65. For the primary

Table 1. Number and age distribution of children in study samples.

			Mean age (s.d.)
Rural		*n*	(years)
Black	female	124	2.8 (1.1)
	male	125	2.9 (1.1)
	total	249	2.9 (1.1)
Urban			
Black	female	139	2.9 (1.0)
	male	146	2.8 (1.1)
	total	285	2.9 (1.0)
Coloured	female	148	2.7 (1.0)
	male	146	2.7 (1.0)
	total	294	2.7 (1.0)
Indian	female	159	2.3 (1.0)
	male	142	2.5 (1.1)
	total	301	2.4 (1.1)
White	female	177	2.5 (1.1)
	male	140	2.8 (1.1)
	total	317	2.6 (1.1)

Table 2. Percentage of primary incisor teeth erupted at one year in five groups (F, female; M, male; A, all).

	Rural			Urban											
	Black			Black			Coloured			Indian			White		
Tooth	F	M	A	F	M	A	F	M	A	F	M	A	F	M	A
Maxilla															
left central	97	100	99	100	100	100	100	94	97	80	88	84	93	100	97
right central	97	100	99	100	100	100	100	89	95	80	88	84	94	97	96
left lateral	87	96	92	96	97	97	82	89	86	68	73	71	83	78	81
right lateral	87	96	92	96	97	97	82	89	86	70	68	69	86	81	84
Mandible															
left central	97	100	99	100	100	100	100	97	99	87	90	89	99	100	100
right central	100	100	100	96	100	98	100	97	99	81	90	86	97	94	96
left lateral	90	96	93	93	97	95	67	86	77	55	48	52	66	72	69
right lateral	90	96	93	93	94	94	69	89	79	52	45	49	71	75	73

central incisors rural black boys and urban black boys and girls as well as coloured (mixed race) girls had left and right teeth erupted by 12 months (Table 2). Indian children had at least central incisors erupted. For the primary lateral incisors rural and urban black children had more of these teeth erupted than the other groups whereas Indian children had the least.

No statistically significant differences in numbers of incisor teeth erupted were seen for jaw, side and gender within any of the ethnic groups when the chi-squared test was applied (χ^2 values ranged between 0.01 and 3.22; d.f. = 1). Examination for statistically significant differences among ethnic groups showed that significantly fewer incisor teeth were erupted at one year in the Indian children than in the other groups (χ^2 values ranged between 55.63 and 18.65; d.f. = 4).

In our earlier studies of permanent dentition we found that a better fit of the data was obtained when a log transformation of age was used. The present data were treated similarly.

For the canine and molar teeth the mean eruption ages and 95% confidence limits of the mean for each ethnic group are listed in Tables 3–7. For the primary molars, the urban black children had the earliest eruption patterns followed by the rural black and urban coloured groups, the white group and finally the Indian children. This pattern was not followed, however, for the primary canines, which showed the white group to erupt those teeth later than the four other groups. Statistical analysis revealed no statistically significant influences on eruption age of side of jaw, gender or ethnic group.

Discussion

Eruption is a complicated multifactorial process involving the periodontal ligament, fibroblast activity, vascular pressure and tissue pressure. It is slow initially, while the crown is carried towards the oral mucosa, accelerates as it enters the oral cavity and then slows once more.[1] Control of the process is complex

Table 3. Ages of eruption in months for rural black children (CI, confidence interval).

	Female		Male		All	
Primary tooth	Mean	95% CI	Mean	95% CI	Mean	95% CI
Maxilla						
left canine	15.8	12.6–18.0	18.5	15.6–20.3	17.0	15.1–18.5
right canine	15.8	12.6–18.0	18.5	15.6–20.3	17.0	15.1–18.5
left first molar	14.6	11.2–16.6	15.4	12.2–17.4	15.0	13.1–16.3
right first molar	14.6	11.2–16.6	15.4	12.2–17.4	15.0	13.1–16.3
left second molar	24.8	21.7–28.2	23.3	22.3–25.0	24.0	21.2–26.8
right second molar	24.8	21.7–28.2	23.5	22.3–25.0	24.1	21.2–27.2
Mandible						
left canine	16.9	14.4–18.7	19.0	16.3–20.6	17.8	16.1–19.1
right canine	16.9	14.4–18.7	19.0	16.3–20.6	17.8	16.1–19.1
left first molar	14.6	11.2–16.6	15.8	12.7–17.8	15.2	13.3–16.6
right first molar	14.6	11.2–16.6	15.8	12.7–17.8	15.2	12.6–16.6
left second molar	23.9	21.2–26.8	23.0	21.6–24.5	23.2	21.1–25.7
right second molar	23.9	21.2–26.8	22.6	20.9–24.1	23.2	22.0–24.4

Table 4. Ages of eruption in months for urban black children

	Female		Male		All	
Primary tooth	Mean	95% CI	Mean	95% CI	Mean	95% CI
Maxilla						
left canine	12.0	4.1–14.4	16.4	13.8–18.0	14.8	12.2–16.4
right canine	12.0	4.1–15.5	16.8	14.3–18.4	15.0	12.6–16.6
left first molar	10.6	1.2–14.6	14.4	9.8–15.7	12.5	8.4–14.6
right first molar	10.6	1.2–14.6	14.4	9.8–15.7	12.2	7.9–14.4
left second molar	23.3	21.4–25.1	23.4	21.8–25.0	23.4	22.2–24.5
right second molar	23.3	21.4–25.1	23.2	21.5–24.7	23.2	22.1–24.4
Mandible						
left canine	12.0	4.2–15.6	16.80	14.28–18.36	15.0	12.5–16.7
right canine	10.4	1.6–14.8	16.80	14.28–18.36	14.6	11.8–16.4
left first molar	10.6	1.2–14.6	13.68	7.56–15.36	11.9	7.2–14.3
right first molar	10.6	1.2–14.6	13.68	7.56–15.36	11.9	7.2–14.3
left second molar	20.6	18.1–22.7	22.3	20.6–23.8	21.6	18.1–24.2
right second molar	20.9	17.0–23.8	22.3	20.6–23.8	21.7	18.2–24.4

involving nutritional, hormonal, cellular, molecular and physicochemical factors,[1] which vary between individuals, genders and ethnic groups.

Two approaches are used to study tooth eruption in humans —longitudinal and cross-sectional methods.[5] Longitudinal methods give more information, since order of eruption may also be recorded but such studies are time-consuming and difficult to do because of individuals leaving the study. Cross-sectional studies, such as the current investigation, require large numbers but are more practical and, if combined with Probit analysis, provide useful and reliable information.

There have been no eruption studies in Africa comparable to the present investigation, so studies of similar ethnic groups elsewhere in the world have been used. When the South African data are compared with the recent study by Saleem *et al.*,[15] who contrasted eruption times of primary teeth in Pakistani and white Swedish children, the South African Indian group is similar to the Pakistani children, except that eruption of the canines is earlier in the South African sample. A slightly earlier study of Punjabi (Indian) children showed that their teeth erupted earlier than other population groups,[14] but similar to our figures for the Indian children.

The eruption of teeth in the South African white children is similar to that reported by Demirjian[30] in a study of French Canadian white children, as well as to the findings of Tanguay, Demirjian and Thibault,[31] and Hägg and Taranger,[11] and a recent study by Ramirez, Planells and Barberia[5] with Spanish children.

In the current study eruption times in both girls and boys were similar, the opposite finding to Infante[26] among US black and white children, among whom eruption was earlier in boys. Further variation is shown in Punjabi children, among whom girls' teeth erupted earlier.[14] In the current study rural black children erupted their teeth later than their urban compatriots, although this difference was not statistically significant. No clear pattern therefore exists; there is variation from group to group.

These findings are important for anthropological and forensic reasons and also in respect of dietary patterns and length of exposure of teeth to foods, and during and after weaning the children. The longer a tooth is exposed in the oral cavity, the greater is the chance of developing dental caries.[12,32] Our results are important for South Africa because the government is concentrating on primary health care and it is clear that no one group manifests significantly early primary tooth eruption that requires special emphasis on preventative dentistry.

The reasons for variations in eruption times between groups are obscure. While malnutrition may play a role, genetic influences are probably the more important. This was suggested more than 50 years ago by Steggerda and Hill.[33]

No evidence of severe malnutrition was seen by experienced clinicians, in any of the South African groups, although earlier episodes of this could not be excluded. Malnutrition in children examined in studies by El Lozy *et al.*[34] with Tunisian children, by

Table 5. Ages of eruption in months for urban coloured children.

	Female		Male		All	
Primary tooth	Mean	95% CI	Mean	95% CI	Mean	95% CI
Maxilla						
left canine	17.3	15.4–19.0	17.3	15.4–18.8	17.3	16.0–18.5
right canine	17.3	15.4–19.0	17.3	15.4–18.8	17.3	16.0–18.5
left first molar	15.0	13.1–16.2	14.9	13.2–16.3	15.0	13.8–16.0
right first molar	15.0	13.2–16.4	14.9	13.2–16.3	14.9	13.8–15.7
left second molar	23.7	22.0–25.3	25.0	21.7–28.0	24.2	22.4–25.9
right second molar	23.4	22.0–24.8	24.7	21.6–27.6	25.0	22.4–25.7
Mandible						
left canine	17.8	16.0–19.6	18.1	16.3–19.7	17.9	16.7–19.1
right canine	17.8	16.0–19.6	17.4	15.4–19.0	17.5	16.3–18.7
left first molar	15.0	13.2–16.4	14.9	13.2–16.3	15.0	13.8–15.0
right first molar	15.2	13.4–16.8	14.9	13.2–16.3	15.1	13.9–16.1
left second molar	23.1	21.4–24.7	22.7	20.8–24.5	22.9	21.6–24.1
right second molar	22.7	21.0–24.1	22.9	21.0–24.7	22.8	21.5–24.0

Table 6. Ages of eruption in months for urban Indian children.

	Female		Male		All	
Primary tooth	Mean	95% CI	Mean	95% CI	Mean	95% CI
Maxilla						
left canine	17.9	16.4–19.6	17.3	15.7–18.8	17.6	16.6–18.7
right canine	17.9	16.4–19.6	17.5	16.0–19.2	17.8	16.7–18.8
left first molar	16.0	14.6–17.3	16.0	14.6–17.6	16.0	15.1–16.9
right first molar	15.8	14.8–17.2	16.0	14.6–17.6	16.0	15.0–16.9
left second molar	28.0	22.0–36.2	27.5	21.5–34.9	27.7	21.7–35.4
right second molar	28.0	20.4–39.7	28.3	25.6–31.8	28.1	16.6–49.7
Mandible						
left canine	18.4	16.7–20.0	18.1	16.4–19.7	18.2	17.0–19.3
right canine	18.1	16.6–19.7	18.1	16.4–19.7	18.1	17.0–19.2
left first molar	16.0	14.8–17.3	16.2	14.9–17.9	16.1	15.1–17.0
right first molar	16.1	14.9–17.4	16.2	14.9–17.9	16.2	15.2–17.2
left hand molar	26.3	20.6–34.1	26.5	21.7–32.3	26.4	21.1–33.1
right second molar	26.9	21.6–33.8	26.3	21.5–31.8	26.5	21.6–32.6

Table 7. Ages of eruption in months for urban white children.

	Female		Male		All	
Primary tooth	Mean	95% CI	Mean	95% CI	Mean	95% CI
Maxilla						
left canine	19.4	17.9–20.8	16.3	13.4–18.7	18.5	17.0–19.7
right canine	19.2	17.8–20.8	17.2	14.4–19.4	18.6	17.3–19.8
left first molar	15.1	13.4–16.4	13.9	10.8–16.1	14.6	13.2–15.8
right first molar	14.9	13.2–16.2	13.9	10.7–16.4	14.6	13.2–15.8
left second molar	25.2	20.4–32.2	25.3	21.2–28.8	25.3	20.8–30.1
right second molar	26.0	20.3–33.6	25.9	21.6–29.5	25.9	20.9–31.1
Mandible						
left canine	19.1	17.6–20.5	18.2	15.6–20.5	18.8	17.6–20.2
right canine	19.1	17.6–20.5	18.0	15.4–20.3	18.7	17.5–20.0
left first molar	15.1	13.8–16.4	14.9	12.0–16.9	15.0	13.7–16.2
right first molar	15.1	13.8–16.4	14.8	12.0–16.9	15.0	13.7–16.2
left second molar	24.4	20.6–28.8	25.2	21.4–28.4	24.6	21.1–28.2
right second molar	24.1	20.5–28.4	25.3	20.9–28.9	24.5	21.0–28.1

Alvarez *et al.*,[12] Alvarez and Navia[32] with Peruvian children, by Visweswara, Susheela and Swaminathan[35] with Indian children, and by Delgado *et al.* with Guatemalan children and premature, low-birth-weight United States children,[21] suggest malnutrition can delay the emergence of primary teeth prior to 18 months of age, followed with a catch-up period. Malnutrition should not have influenced the South African findings.

Conclusions

The patterns of eruption of primary dentition have been established for five South African groups. Both girls and boys as well as all groups investigated revealed essentially the same tooth eruption behaviour.

Received 14 October; accepted 28 November 1996.

1. Kardos T.B. (1996). The mechanism of tooth eruption. *Br. dent. J.* **181**, 91–95.
2. Savara B.S. and Steen J.C. (1978). Timing and sequence of eruption of permanent teeth in a longitudinal sample of children from Oregon. *J. Am. dent. Assoc.* **97**, 209–214.
3. Hitchcock N.E., Gilmour A.I., Gracey M. and Kailis D.G. (1984). Australian longitudinal study of time and order of eruption of primary teeth. *Community Dent. oral Epidemiol.* **12**, 260–263.
4. Garn S.M., Sandusky S.T., Nagy J.M. and Trowbridge F.L. (1973). Negro-Caucasoid differences in permanent tooth emergence at a constant income level. *Archs. oral Biol.* **18**, 609–615.
5. Ramirez O., Planells P. and Barberia E. (1994). Age and order of eruption of primary teeth in Spanish children. *Community Dent. oral Epidemiol.* **22**, 56–59.
6. Ferguson A.D., Scott R.B. and Bakwin H. (1957). Growth and development of negro infants. *J. Pediatr.* **50**, 327–331.
7. McGregor I.A., Thomson A.M. and Billewicz W.Z. (1968). The development of primary teeth in children from a group of Gambian villages and critical examination of its use for estimating age. *Br. J. Nutr.* **22**, 307–314.
8. Bambach M., Saracci R. and Young H.B. (1973). Emergence of deciduous teeth in Tunisian children in relation to sex and social class. *Hum. Biol.* **45**, 435–444.
9. Billewicz W.Z., Thomson A.M., Baber F.M. and Field C.E. (1973). The development of primary teeth in Chinese (Hong Kong) children. *Hum. Biol.* **45**, 229–241.
10. Mukerjee D.K. (1973). Deciduous dental eruption in low income group Bengali Hindu children. In Mongraph no. 28, *J. trop. Pediatr. environ. Child Hlth* **19**, 193–248.
11. Hägg U. and Taranger J. (1986). Timing of tooth emergence. *Swed. dent. J.* **10**, 195–206.
12. Alvarez J.O., Lewis C.A. and Saman C. (1988). Chronic malnutrition and deciduous dental caries in Peruvian children. *Am. J. clin. Nutr.* **48**, 368–372.
13. Fadavi S., Punwani I.C., Adeni S. and Vidyasagar D. (1992). Eruption pattern in the primary dentition of premature low-birth-weight children. *J. Dent. Child.* **59**, 120–122.
14. Kaul S.S., Pathak R.K. and Santosh K.K. (1992). Emergence of deciduous teeth in Punjabi children, North India. *Zeit. Morph. Anthropol.* **79**, 25–34.
15. Saleem M.A., Hägg U., Jalil F. and Zaman S. (1994). Timing of emergence of individual primary teeth. *Swed. dent. J.* **18**, 107–112.
16. Boutourline-Young H. (1969). The arm circumference as a public health index of protein calorie malnutrition of early childhood XII. Arm measurements as indicators of body composition in Tunisian children. *J. trop. Pediatr.* **15**, 177–260.
17. Cifuentes E. and Alvarado J. (1973). Assessment of deciduous dentition in Guatemalan children. In Monograph no. 28, *J. trop. Pediatr.* **19**, 193–248.
18. Infante P.F. and Owen G.M. (1973). Relation of chronology of deciduous tooth emergence to height, weight, and head circumference in children. *Arch. oral Biol.* **18**, 1411–1417.
19. Habicht J.P., Martorell R., Yarbrough C., Malina R.M. and Klein R.E. (1974). Height and weight standard for pre-school children. How relevant are ethnic differences in growth potential? *Lancet* **1**, 611–614.
20. Trupkin D.P. (1974). Eruption patterns of the first primary tooth in infants who were underweight at birth. *J. Dent. Child.* **41**, 279–282.
21. Delgado H., Habicht J.P., Yarbrough C., Lechtig A., Martorell R., Malina R.M. and Klein R.E. (1975). Nutritional status and the timing of deciduous tooth eruption. *Am. J. clin. Nutr.* **28**, 216–224.
22. Jelliffe E.F.P. and Jelliffe D.B. (1973). Deciduous dental eruption, nutrition and age assessment. In Monograph no. 28, *J. trop. Pediatr.* **19**, 193–248.
23. Blankenstein R., Cleaton-Jones P.E., Luk K.W. and Fatti L.P. (1990). The onset of eruption of the permanent dentition amongst South African Black children. *Arch. oral Biol.* **35**, 225–228.
24. Blankenstein R., Cleaton-Jones P.E., Maistry P.J., Luk K.W. and Fatti L.P. (1990). The onset of eruption of permanent teeth amongst South African Indian children. *Ann. hum. Biol.* **17**, 515–521.
25. Lavelle C.L.B. (1975). A note on the variation in the timing of deciduous tooth eruption. *J. Dent.* **3**, 267–270.
26. Infante P.F. (1974). Sex differences in the chronology of deciduous tooth emergence in white and black children. *J. dent. Res.* **53**, 418–421.
27. Gill P.S. and Johnson M. (1995). Ethnic monitoring and equity. *Br. med. J.* **310**, 908.
28. Finney D.J. (1971). *Probit Analysis*, 3rd edn. Cambridge University Press, Cambridge.
29. Statistical Analysis System (1989). *SAS/STAT User's Guide*, version 6, 4th vol. 2, pp. 1324–1350. SAS Institute Inc, Cary, NC.
30. Demirjian A. (1986). Dentition. In *Human Growth*, eds F. Falkner and J.M. Tanner, 2nd edn, pp. 269–298. Baillere Tindell, London.
31. Tanguay R., Demirjian A. and Thibault H.W. (1984). Sexual dimorphism in the emergence of the deciduous teeth. *J. dent. Res.* **63**, 65–68.
32. Alvarez J.O. and Navia J.M. (1989). Nutritional status, tooth eruption, and dental caries: a review. *Am. J. clin. Nutr.* **49**, 417–426.
33. Steggerda M. and Hill T.J. (1942). Eruption time of teeth among whites, negroes, and Indians. *Am. J. Orthodont.* **28**, 361–370.
34. El Lozy M., Reed R.B., Kerr G.R., Boutourline E., Tesi G., Gharmy M.T., Stare F.J., Kallal Z., Turki M. and Hemaidan N. (1975). Nutritional correlates of child development in Southern Tunisia. IV. The relation of deciduous dental eruption to somatic development. *Growth Dev. Aging* **39**, 209–221.
35. Visweswara K., Susheela T.P. and Swaminathan M.C. (1973). Association of growth status and deciduous teeth eruption among rural Indian children. In Monograph no. 28, *J. trop. Pediatr. environ. Child Hlth* **19**, 193–248.

⇦ page 80

Monad to Man: The Concept of Progress in Evolutionary Biology. By Michael Ruse. Pp. 628. Harvard University Press. $49.95.

Life's Splendid Drama: Evolutionary Biology and the Reconstruction of Life's Ancestry. By Peter J. Bowler. Pp. 525. University of Chicago Press. $37.95.

An Inordinate Fondness for Beetles. By Arthur V. Evans and Charles L. Bellamy. Holt. $40.

The Great Human Diasporas: The History of Diversity and Evolution. By L.L. Cavalli-Sforza. $15 (pbk).

The Idea of Biodiversity: Philosophies of Paradise. By David Takacs. Pp. 393. Johns Hopkins University Press. $35.95.

The Biological Universe: The Twentieth-Century Extraterrestrial Life Debate and the Limits of Science. By Steven J. Dick. Pp. 578. Cambridge University Press. $54.95.

Darwin's Dangerous Idea: Evolution and the Meanings of Life. By Daniel C. Dennett. Penguin. £9.99 (pbk).

Cretaceous-Tertiary Mass Extinctions: Biotic and Environmental Changes. Edited by Norman MacLeod and Gerta Keller. Pp. 575. Norton. $55.

Dinosaur Extinction and the End of an Era: What the Fossils Say. By J. David Archibald. Pp. 237. Columbia University Press. $57 (hbk); $29 (pbk).

Brain Mapping: The Methods. By Arthur W. Toga and John C. Mazziotta. Pp. 471. Academic. $145.

Ion Channels: Molecules in Action. By David J. Aidley and Peter R. Stanfield. Pp. 307. Cambridge University Press. $74.95 (hbk); $29.95 (pbk).

The Price of Meat. By Danny Penman. Gollancz. £9.99

Theory-Based Assessment, Treatment and Prevention of Sexual aggression. By Gordon Nagayama. Oxford University Press. $39.95.