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STUDIES OF MACROPODIDAE IN QUEENSLAND

7. AGE ESTIMATION AND REPRODUCTION IN THE AGILE WALLABY (WALLABIA AGILIS (GOULD))

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SUMMARY

A biological study of the agile wallaby was undertaken using animals collected in north Queensland. Methods of age estimation of both pouch young and adults, based on body measurements and progression of the cheek tooth-row respectively, have been established.

Reproduction follows the more usual macropod pattern, with a gestation period of 29–33 days and an oestrus cycle of similar duration. Birth is followed by a post-partum mating which results in the establishment of a quiescent embryo, which develops in time to be born when the first pouch young is nearly 7 months old or within 24–27 days if the first pouch young is removed prematurely. Both sexes may attain sexual maturity at about one year old, and breeding is continuous with no evidence of a seasonal anoestrus.

I. INTRODUCTION

The agile wallaby (*Wallabia agilis* (Gould)) is found abundantly throughout coastal northern Australia, where it is known as a minor pest of tropical agriculture, particularly sugar cane in Queensland (Roff and Kirkpatrick 1962, 1966). The species occurs in New Guinea and adjacent islands. Small populations are present also on some of the islands of Moreton Bay, many hundreds of miles south of the known mainland distribution. Several sub-species, based largely on geographical distribution, have been recognized over that range (Iredale and Troughton 1934; Tate 1948). A fossil macropod, *"Halmaturus" siva* De Vis, difficult to distinguish morphologically from *W. agilis,* is found abundantly in pleistocene deposits on the Darling Downs (A. Bartholomai, personal communication), possibly indicating a wider southern distribution in prehistoric times: today the appropriate ecological niche in this area is occupied by the red-necked wallaby (*Wallabia rufogrisea* (Desmarest)).

The study described in this paper was of field-collected wallabies taken near Townsville, north Queensland, during the 15 months from April 1965 to June 1966. Yard studies were commenced at the Department of Primary Industries Research Station, Hermitage, in January 1966, and have continued to the present.

II. MATERIALS AND METHODS

Field studies.—Three hundred adult wallabies were collected, by shooting, from several localities within 30 miles of the city of Townsville. The area involved is illustrated and relevant rainfall and temperature data during that period are given in Lavery and Johnson (1968).

From each specimen the head and relevant parts of the reproductive system were removed for laboratory examination. Pouch young were removed, and lengths of tail and hind feet recorded. Each head was cleaned for the skull, from which the molar index (see Kirkpatrick 1964) was recorded. Ovaries and uteri were examined for evidence of reproductive activity, and testes for sperm production.

Yard studies.—Fifteen large pouch young, six males and nine females, taken during the field study were reared by hand at Townsville and when independent transferred to yards at Hermitage. Several others collected by local residents and hand-reared to maturity were also donated: for some of these dates of collection and descriptions of size at capture were available. Observations as close to daily as possible were made of reproductive activity, and dates of oestrus and birth were recorded for each female. Pouch young were examined at weekly intervals and lengths of tail and hind feet (excluding nail) recorded. Ages at which the eyes opened and the pouch was vacated were noted.

A number of older animals, some born in the yards and thus of known age, and others of estimated age taken as pouch young in the field either died or were sacrificed. The skulls of these animals were prepared and the molar index of each was read.

III. RESULTS

(a) Age Estimation

Pouch young.—Measurements of length of tail and mean length of hind feet of nine pouch young, born to seven different females and sired by five different males, are given as a scatter diagram in Figure 1. Ages at specified lengths of tail and hind feet, calculated from the original data, are presented in Table 1 in such a way as to provide a ready means of age determination of pouch young up to 210 days. The eyes opened at a mean age of 126 days, range 118–132 days, and permanent vacation of the pouch of seven which completed pouch life occurred at a mean age of 208·5 days, range 200–220 days.

TABLE 1

AGES OF POUCH YOUNG ESTIMATED FROM LENGTH OF TAIL AND MEAN LENGTH OF HIND FEET

Length of Tail (mm)	Age (days)	Days added per Additional mm	Mean Length of Hind Feet (mm)	Age (days)	Days added per Additional mm
6	0	2·5	3	0	3·0
10	10	1·3	10	22	2·5
20	23	1·1	20	47	1·9
30	34	0·9	30	66	1·5
60	61	0·8	50	96	1·0
100	93	0·7	90	136	0·7
120	107	0·5	120	157	0·9
170	132	0·4	150	184	1·5
220	152	0·3	160	200	2·5
340	185	0·2	..	..	..
400	200	0·5	..	..	..
Standard deviations (days) at ages:	10 100 200	±0·3 ±1·5 ±7·0	Standard deviations (days) at ages:	10 100 200	±0·3 ±1·0 ±6·0

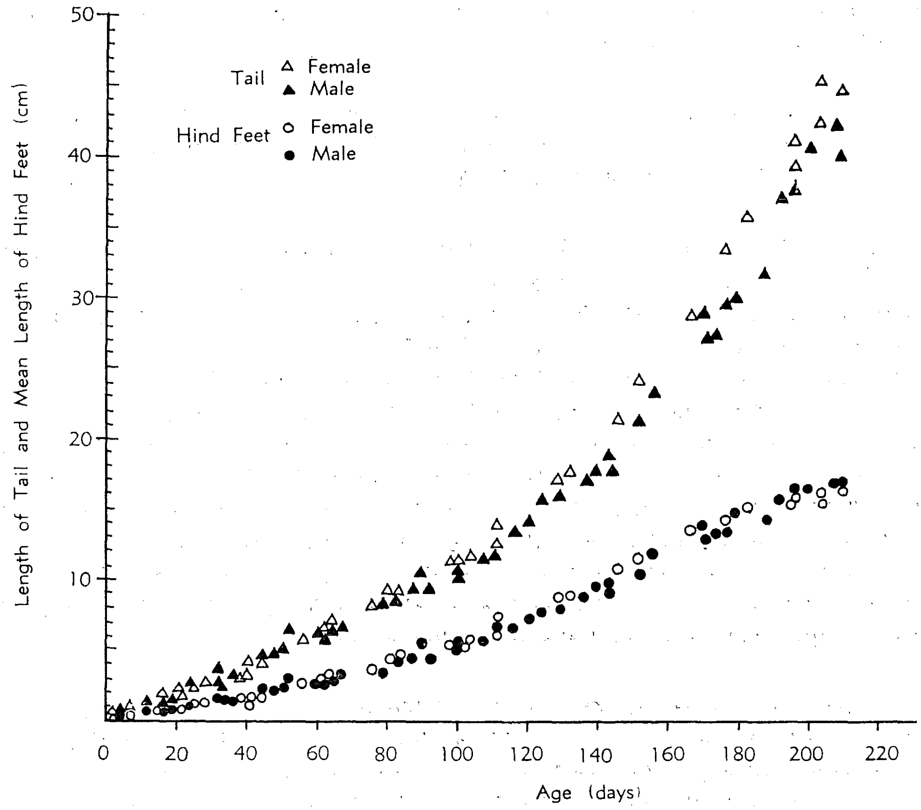

Fig. 1.—Pouch young of the agile wallaby: length of tail and mean length of hind feet plotted against age. Mean duration of pouch life, 208·5 days.

Adults.—The molar indices of eight adult wallabies of known age and of seven whose age had been estimated as pouch young at capture up to 4 years 78 days were available, and the regression of $\log_{10}$ (age in days) on molar index was calculated as follows:

$$\log_{10} \text{(age in days)} = 2 \cdot 1723 + 0 \cdot 34442 \text{ M.I.}$$

Confidence limits (95%) lie between ±21% and ±23% of the estimated age.

This regression was tested on one captive animal which died at the age of 2,650 days: molar index was 3·7, giving an estimated age in days of 2,797±616.

(b) Reproduction

Data were taken from both yard and field studies, as indicated below. Observations on oestrus in the yards were made infrequently, as apparently most of the matings in the yards occurred at night, and then the only evidence of copulation (daily vaginal smears were not practicable) was the presence of a vaginal plug, and this was found only on relatively few occasions.

Oestrus cycle.—Duration of the oestrus cycle, as indicated by the interval between successive matings, varied from 29 to 34 days in eight observations recorded from four animals.

Gestation period.—The interval between mating and birth was recorded accurately only on four occasions, involving four different animals: the times recorded were 29·0, 29·5, 30·5 and 33·1 days.

Parturition.—Birth was observed on seven occasions. In each instance, the procedure followed was similar to that of the red kangaroo as recorded by Sharman and Pilton (1964). The animal moved about restlessly for some time—usually more than an hour—until it found a suitable site which provided it with some support as it assumed the birth position. For birth, the animal sat on the base of the tail with the tail forward between the hind legs, and with the body leaning forward in such a way as to bring the head close to the urogenital opening and pouch. Birth was accompanied by a small amount of clear fluid and a quantity of blood which the mother cleaned away as the newborn young scrambled toward the pouch opening: the time taken for the journey from urogenital opening to pouch entrance was of the order of one minute. Unless disturbed, the mother remained a further 10 to 15 min in the birth position licking around the urogenital opening.

Post-partum oestrus.—Oestrus invariably occurred in yard animals within 24 hr after birth, and frequently within an hour. In several instances, the interest and attention of males (evidently anticipating the post-partum oestrus) indicated an approaching birth and interfered with the female in its attempt to find a suitable place in which to give birth.

That the same event occurred in the wild was indicated by the presence of embryos at the blastocyst stage in the uteri of females with young in the pouch Unfortunately, it was not possible to examine the reproductive systems of most of the field-collected females for embryos as these deteriorated badly in storage between collection and later laboratory examination. Reproductive systems from 10 females carrying young ranging from 15 to 160 days were examined shortly after collection: in all of these a corpus luteum of lactation was present in one ovary, and a corpus luteum of pregnancy in the other. A blastocyst, presumably quiescent, was found in eight of the 10. Unfertilized ova were not present in this sample.

Development of the quiescent embryo.—Pouch young of ages 110, 162, 174 and 177 days were removed from animals known to have mated post-partum and second young were born, presumably from the quiescent embryos, 27·7, 27·0, 24·5 and 24·2 days later respectively. Pouch young of ages 29, 84 and 110 days were removed from others which did not give birth to a second young but came into oestrus at 27·5, 32·9 and 28·5 days respectively after the removals. Seven pouch young of females in which post-partum oestrus and mating had occurred were allowed to develop normally to independence; second young were born, apparently from the quiescent embryos, in five of these at 200, 202, 205, 208 and 215 days from birth of the first young (which as indicated above coincided with the post-partum oestrus). In the other two, an oestrus occurred when the pouch young were 210 and 220 days old.

Breeding season.—Date of birth of each of 135 field-collected pouch young (including one set of twins) was calculated by subtracting estimated age from date of collection, and the distribution of births by months is given in Table 2. The null hypothesis that this distribution was no different from that expected if births were evenly distributed throughout the year was tested by chi-square, the value of which was not significant.

TABLE 2

MONTH OF BIRTH OF 135 FIELD-COLLECTED POUCH YOUNG

Month	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
No. born	9	14	8	15	8	13	14	8	16	9	10	11

Sex ratio of pouch young.—Of 135 pouch young collected, 65 were males and 70 females.

Minimum breeding ages.—The estimated age of the youngest field-collected male with sperm present in the epididymis was 385 days, and of the oldest without 401 days. The estimated age at oestrus of the youngest field-collected female with a pouch young was 330 days, and the oldest with no evidence of reproductive activity, as determined by visual inspection of pouch and ovaries, was 480 days. The age of the youngest captive male to show signs of reproductive activity was 420 days, and the age of the youngest captive female to mate successfully was 334 days. All females born in captivity had mated by the end of the first year.

IV. DISCUSSION

Ages of pouch young of the agile wallaby may be determined readily using measurements of tail and hind feet found effective for many other Macropodidae (Shield and Woolley 1961; Sadlier 1963; Sharman, Frith, and Calaby 1964; Kirkpatrick 1965; Sharman, Calaby and Poole 1966). The index of molar progression used for estimating the ages of adults of several other Macropodidae (Kirkpatrick 1965) has been found useful for this species also.

Progression of the check tooth-row is rapid compared with that observed in other Macropodidae, and as the highest molar index encountered in the field was 4·25, giving an estimated age in days of 4326±990, a relatively short life-span of the order of 10–12 years is indicated. This short life-span, however, is consistent with the short pouch life of 7 months and the early age (1 year) at which sexual maturity is reached.

Reproduction follows the more usual macropod pattern (Sharman, Calaby, and Poole 1966), involving a gestation period of similar duration to an oestrus cycle, and with parturition followed closely by ovulation, oestrus and mating from which a quiescent embryo results. The variability in duration of the few gestation periods observed (29–33·1 days) is noteworthy, and is paralleled by the variability in the interval between removal of a pouch young and birth from the quiescent embryo (24·2–27·7 days). As the shorter intervals followed removal of pouch young older than 170 days, however, the possibility cannot be excluded that development of the quiescent embryo had commenced before removal of the pouch young. Those females which did not give birth from a quiescent embryo following either removal or final eviction of the pouch young came into oestrus and mated at the time birth from the quiescent embryo was expected. In these either fertilization post-partum was unsuccessful or the quiescent embryo had died, and it appears that the cycle of ovarian and uterine events which results in ovulation and oestrus following removal of a pouch young, or completion of the pouch life of a young, is not affected by the presence of a quiescent embryo.

Distribution of births throughout the year (Table 2) indicates that breeding is continuous, although the possibility that a seasonal anoestrus has been obscured by births from quiescent embryos consequent on a high mortality of pouch young cannot be excluded. Reproduction was continuous in the captive animals, however, and a seasonal anoestrus in wild animals seems unlikely.

Both sexes may attain sexual maturity at an age of approximately 1 year both in captivity and in the field. Some wild-collected females, however, were apparently not reproducing at an estimated age of 16 months: probably adverse local field conditions delayed the onset of reproduction in these unmated females, as has been observed in both the red kangaroo (Newsome 1966) and the grey kangaroo (Kirkpatrick and McEvoy 1966). As overall field conditions were essentially favourable during this investigation, it was not possible to study the effects of drought on this species.

The life history of the agile wallaby, as indicated by this study, involves a 7-month pouch life, attainment of sexual maturity at about 1 year, with a reproductive potential in females of one young every 7 months, an interval which may be extended to 8 months if the quiescent embryo fails to develop. Under the normally favourable conditions of tropical coastal Queensland, rapid population growth (for a macropod) could be expected. That this happens is confirmed by the abundance of the species wherever suitable habitat occurs.

V. ACKNOWLEDGEMENTS

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REFERENCES

IREDALE, T., and TROUGHTON, E. le G. (1934).—A check-list of the mammals recorded from Australia. *Mem. Aust. Mus.* 6:1-120.

KIRKPATRICK, T. H. (1964).—Molar progression and macropod age. *Qd J. Agric. Sci.* 21:163-5.

KIRKPATRICK, T. H. (1965).—Studies of Macropodidae in Queensland. 2. Age estimation in the grey kangaroo, the red kangaroo, the eastern wallaroo and the red-necked wallaby, with notes on dental abnormalities. *Qd J. Agric. Anim. Sci.* 22:301-17.

KIRKPATRICK, T. H., and MCEVOY, J. S. (1966).—Studies of Macropodidae in Queensland. 5. Effects of drought on reproduction in the grey kangaroo (*Macropus giganteus*). *Qd J. Agric. Anim. Sci.* 23:439-42.

LAVERY, H. J., and JOHNSON, P. M. (1968).—Mammals and birds of the Townsville district, north Queensland. 1. Introduction and mammals. *Qd J. Agric. Anim. Sci.* 25:29-37.

NEWSOME, A. E. (1966).—Influence of food on breeding in the red kangaroo in central Australia. *C.S.I.R.O. Wildl. Res.* 11:187-96.

ROFF, C., and KIRKPATRICK, T. H. (1962).—The kangaroo industry in Queensland. *Qd J. Agric. Sci.* 19:385-401.

ROFF, C., and KIRKPATRICK, T. H. (1966).—The kangaroo industry in Queensland. First supplement, 1961–1965. *Qd J. Agric. Anim. Sci.* 23:467-73.

SADLIER, R. M. F. S. (1963).—Age estimation by measurement of joeys of the euro *Macropus robustus* Gould in Western Australia. *Aust. J. Zool.* 11:241-9.

SHARMAN, G. B., CALABY, J. H., and POOLE, W. E. (1966).—Patterns of reproduction in female diprotodont marsupials. pp 205-232 in Rowlands, I. W. (ed): Comparative biology of reproduction in mammals. Symposia of the Zoological Society of London No. 15.