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WEIGHT DEVELOPMENT OF HAND-REARED CALLITRICHIDS

Michael Schröpel

Birth weights of various callitrichid species in the Magdeburg Zoo were reported by Schröpel (1989) and were compared to data from research journals. Usually, the birth weights of callitrichids may only be taken from still-born animals, or from neonates that have been neglected by their mothers and are available to be raised by hand. Hand-rearing enables firsthand observation and measurement of the weight development of the subject during ontogenesis, and allows for comparison of the subject to members of its own and other species. For parent-reared infant callitrichids that cannot be weighed, it is possible to observe their weight development through physical and behavioural development.

In general, we observed no differences between the development of parent-reared and hand-reared infant callitrichids at the Magdeburg Zoo. Even the twins of golden-handed tamarins (*Saguinus midas*) that were separated at birth – the male raised by hand, the female by her parents – did not demonstrate any differences in their morphological and behavioural development.

The infants for which weight development is reported here grew up free of disease or other complications. This report covers the cases of three (2.1) cotton-top tamarins (*Saguinus oedipus*) from two separate births in 1987, two (2.0) golden-handed tamarins (*Saguinus midas*) born at the end of 1999 and in September 2001, one (1.0) golden lion tamarin (*Leontopithecus rosalia*) born in March 2001, and seven (2.5) common marmosets (*Callithrix jacchus*) from three separate births in 2000 and 2001.

Two of the common marmosets came from a quadruple birth; the remaining two quadruplets were reared by their parents, and all four young survived. The neonate hand-reared common marmosets weighed 20 grams after their births. These weights are considered at the low end for this species. The other five hand-reared common marmosets included one set of twins and one set of triplets. The sole golden lion tamarin came from a triplet birth. One of the

triplets was stillborn; a second survived only one day with its parents. We found the third neonate with low body temperature, an uncut umbilical cord, and shallow respiration. The newborn cotton-top tamarins were slightly injured, as immediately after birth their mother dropped and bit them.

Schröpel (1988a) wrote in detail about methods for hand-rearing cotton-top tamarins. From the first day of life, all of the hand-reared callitrichids are carried close to the body of the “human parent” – usually on a piece of fur that has been wrapped around the human parent’s arm. (At one time, the newborn cotton-top tamarins were put in a heating box during the first days of their life.) While clinging to the “fur” of the human parent, the infant callitrichid experiences movements of the keeper similar to the natural movement of its parents. This supports the development of their sensory perception, communication and social behaviour. However, if the subject is placed in a rearing-box when removed from its parents, this support is unavailable, and there is the danger that “Kaspar Hauser Syndrome” may develop. In my opinion, the rearing method we implemented is important, even essential to achieve a normal social ontogenesis in young primates, because infant primates are carried all the time by their mother or father (Schröpel, 1982). There is a difference in the rearing of nesting mammals. Indeed, some keepers are also using the method of “parking” in the hand-rearing of primates. In most cases, we reintegrate the young hand-reared callitrichids into the family group after three months, with a high rate of success. In the meantime, some of the hand-reared subjects have become parents themselves and have successfully reared their own infants.

Initially, the newborn callitrichids are bottle-fed every two hours with a human infant milk formula; the quantity is dependent upon the newborn’s need. In the first days of life the quantity consumed is hardly measurable. From

the first day, there is a four-hour break in feeding during the night, and with normal development, the interval increases to six hours after one week of life. After approximately 10 days, the intervals between the feedings are extended to three hours during the day. After 15 to 20 days, depending upon the individual, the infant gradually receives solid food. Normally, the infants determine when they will begin to eat solid food by showing interest in the human parent’s mouth and the chewing motion. In a natural rearing, infants regularly steal food from their father’s mouth. In hand-rearing, the infant callitrichids receive banana pulp, apple pulp, and biscuit as the first solid foods with other foods introduced gradually. By approximately 10 weeks there are longer intervals between formula feedings.

During hand-rearing the infants are weighed daily. Usually the daily weighing ends when the subjects reach between 80 and 100 days, because the young callitrichids become too agile, and the measurements are not exact. The birth weights of the cotton-top tamarins were 47 g and 48 g (both males from a twin birth) and 40 g (female from a triplet birth). The two male golden-handed tamarins (from separate twin births) weighed 41 g and 53 g. The male golden lion tamarin (from a triplet birth) weighed 65 g, and the newborn common marmosets weighed between 20 g and 28 g.

The development of the total body weights for these four species of hand-reared callitrichids is shown in Figure 1a. The weight curves on the diagram increase in a gradually linear fashion until the subjects reach 90 days of age. The increase in the curves is shallower, however, in the first two weeks of life. The hand-reared *Saguinus midas* and *Leontopithecus rosalia* demonstrate a sine-like progress (less pronounced in *Leontopithecus*) with slow growth at the beginning, more rapid growth between three and 10 weeks, and finally slow growth again.

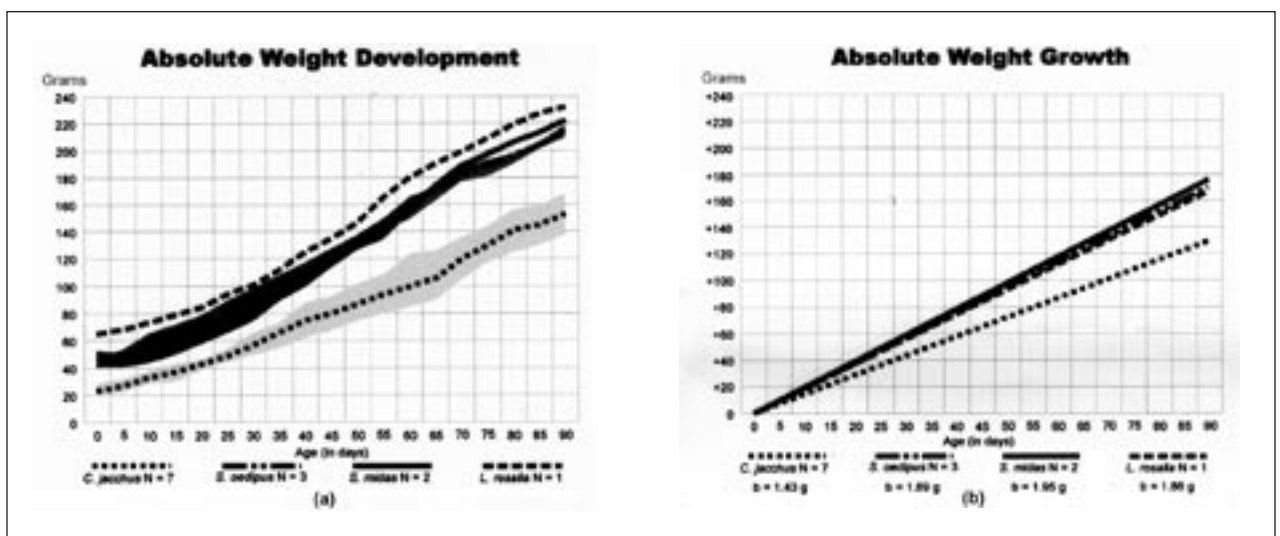


Figure 1. (a) Absolute weight development of *Callithrix jacchus*, *Saguinus oedipus*, *Saguinus midas*, and *Leontopithecus rosalia*. (b) Absolute weight gain of the callitrichids studied, presented as a regression line. *S. oedipus*, *S. midas*, and *L. rosalia* gain weight in the same scale, *C. jacchus* slightly less.



Figure 2. Regression lines of the weight development on a percentage basis to the birth weight.

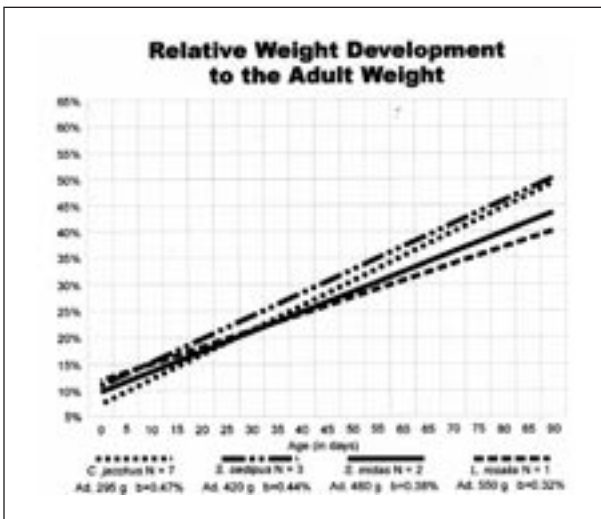


Figure 3. Relative weight development of the studied callitrichids to the adult weight of the different species, shown as regression lines.

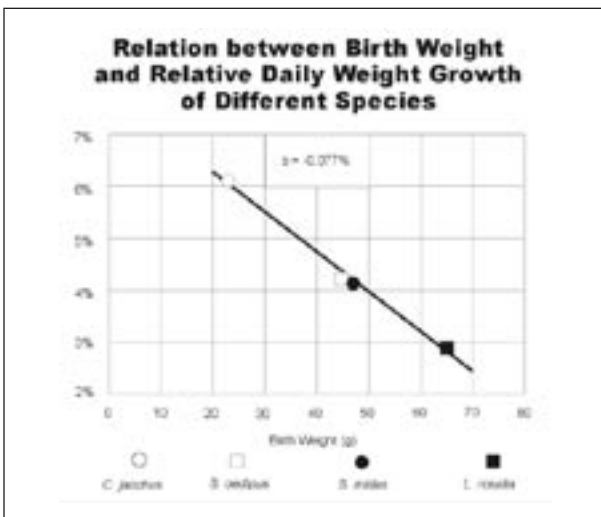


Figure 4. Possible dependence of the weight development of callitrichids to the birth weight of the respective species.

Kirkwood (1985) reported the weight development of callitrichids as a simple exponential curve with a flattening gradient. In our current results we will proceed on the assumption that a gradual linear increase is generally typical in the first three months of life. If the weight gain of the individuals from each species is averaged over the first three months, then the common marmosets gain their body weight by 1.43 g daily; the golden-handed tamarins and the cotton-top tamarins by 1.95 g and 1.89 g per day, respectively; and the golden lion tamarin by 1.86 g daily. The tamarins and the lion tamarin are not notably different in their absolute weight increase (Fig. 1b).

It was noticeable while recording the weight measurements that the various species doubled their birth weight at different times while undergoing the same regimen of artificial rearing. In *C. jacchus* the birth weight doubled between days 18 and 26, in *S. oedipus* between days 27 and 28, in *S. midas* at days 32 and 35, and in *L. rosalia* at day 42. To compare the weight development among the species we computed the daily weight increase on a percentage basis of the birth weight (Fig. 2). There is a significant negative correlation between birth weight and weight development on a percentage basis ($p < 0.05$ to $p < 0.001$). Only between *S. midas* and *S. oedipus* is the difference not significant; however, the birth weight of both these species differs only minimally. The birth weight of *C. jacchus* increased by 6.11% daily, in *S. oedipus* by 4.22%, in *S. midas* 4.14%, and in *L. rosalia* only 2.90%.

Tardif *et al.* (1993) compared the weight development of infants to their adult weight in *S. oedipus* and *C. jacchus*. The absolute weight development of the two species was different, but the relative curves of the adult weights were nearly identical. The absolute weight development of the infants in Tardif *et al.* (1993) is clearly different from our results in this study, in which the curves increase in a shallower line, as depicted in Figure 1a. Furthermore, the authors did not report the adult weights as the basis for their computation. If we consult the data on body weights of these species as reported in the literature (e.g., in summary Hershkovitz, 1977, and other sources), then the reports concerning the adult weights in *C. jacchus*, for instance, range from 240 g to nearly 400 g. When using different adult weights from the same species as base values, the computed relationships of weight development will be correspondingly different as well. Therefore, we compared the weight development of the individuals reported in the present study with the adult weights of these species found at Magdeburg Zoo. The average adult weights of specimens in the Magdeburg Zoo are: *C. jacchus* – 295 g; *S. oedipus* – 420 g; *S. midas* – 480 g; and *L. rosalia* – 550 g. In this comparison of the weight development in relation to the adult weight, there are no significant differences among the species (Fig. 3).

Present interpretations suggest that the greater the species-specific birth weight, the smaller the weight growth over time on a percentage basis, and the longer the time for full

weight development (Fig. 4). This correlation is almost linear, and is adequately significant with a correlation coefficient of -0.997. The relationship between the adult weight of a species and the weight development of the infants also demonstrates a trend of slower weight development with greater adult weight, but this tendency is not definitely linear. This trend is considerably less correlated, with a correlation coefficient of -0.951.

Yamamoto (1993) compared data drawn from several studies on the behavioural development of the different callitrichid genera. The infants of *Callithrix* start weaning from their parents at the age of eight weeks, *Saguinus* at 10 weeks, and *Leontopithecus* at 14 weeks. These observations coincide with the weight development curves we recorded. Yamamoto (1993) also found a correlation between weight and the time when the young are no longer carried on their parent's back or by another group member. She indicated eight weeks for *Callithrix*, nine weeks for *Saguinus*, and 12 weeks for *Leontopithecus*. Tardif *et al.* (1993), on the other hand, concluded that the duration of the carrying phase is not connected with weight development, but rather with the average species-specific daily path length through their home range. *Saguinus* groups usually travel daily path distances which are clearly longer

than those of *Callithrix*. The carrying phase in the ontogenesis of callitrichids is not determined by one single factor (e.g., body weight or daily path length), but may have multiple causes. There are also differences in the length of the carrying phase between wild and captive individuals. In the zoo setting, for example, some young common marmosets are carried up to the age of 18 weeks. In pygmy marmosets (*Cebuella pygmaea*) this age was 14 weeks (Schröpel, 1988b).

HersHKovitz (1977) summarized reports concerning the age of complete adulthood in callitrichids. He indicated 18 months for *Callithrix* and 24 months for both *Saguinus* and *Leontopithecus*. These observations are confirmed to some extent by our results concerning weight development, although we registered and interpreted the weights only up to the 90th day of life.

Of course, hand-rearing is seldom necessary and it will therefore require some time to demonstrate or negate our results with additional data. Some comparisons of published weight curves from other individuals of the species studied here, or of related species, may only be used indirectly, because the methods of rearing are unknown. Different methods of rearing, and especially the nutrition



Figure 5. Common marmoset, *Callithrix jacchus*. 16 days old.



Figure 6. Cotton-top tamarin, *Saguinus oedipus*. 19 days old.



Figure 7. Golden-handed tamarin, *Saguinus midas*. 4 days old.



Figure 8. Golden lion tamarin, *Leontopithecus rosalia*. 22 days old.

of the infants – milk formula, whether the amount of milk is determined by the keeper or by the infant, starting time of solid food, and so on – may cause different patterns of weight development. For example, the curves of weight development published by Pook (1978) and Tardif *et al.* (1993) for *Saguinus oedipus* increase more slowly than ours, but the values found by Rohrhuber (1987) agree with our data. In addition, Tardif *et al.* (1993) presented weights for *Callithrix jacchus* which are lower than those we found. The values published by Kingston (1975) coincide with our findings.

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INTERACCIONES SOCIALES EN UN GRUPO DE MONOS AUILLADORES *ALOUATTA PALLIATA MEXICANA* EN CAUTIVERIO

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Introducción

Son escasos los estudios que abordan las interacciones sociales intragrupal y la jerarquía de dominancia en los monos aulladores de manto *Alouatta palliata* (Jones, 1980; Domínguez-Domínguez, 1994; Zucker y Clarke, 1998). Una posible razón es la dificultad de registrar eventos puntuales tales como las agresiones directas o la direccionalidad de las interacciones sociales entre los miembros del grupo, particularmente en libertad. No obstante, el agonismo entre machos puede ser severo, siendo a menudo estimado a partir de heridas, cicatrices o mutilaciones (Crockett y Pope, 1988). Las invasiones de machos, las muertes por ataques recibidos durante la lucha con otros machos y los infanticidios asociados, han sido reportados para *A. palliata* (Clarke, 1983). El factor de competición en estos casos está relacionado con el aspecto reproductivo, aunque a un nivel intragrupal es el acceso al alimento el principal factor de competición en los grupos de primates (Van Schaik, 1989).

Como primates básicamente folívoros, los monos aulladores consumen recursos no monopolizables de los que obtienen energía limitada (Milton, 1980). Debido a ello los modelos sociales de Wrangham (1980) y Van Schaik (1989) predicen que el principal tipo de competición esperada sería indirecta (*scramble competition*), ya que los individuos no pueden excluir agresivamente a otros de los recursos. La obtención de recursos tendería a ser igualitaria y todos los sujetos serían afectados igualmente por la escasez de recursos, por lo que las jerarquías se previenen débiles y la tasa agonística muy baja. Por el contrario, la competición directa (*contest competition*) es aquella en la que la distribución de recursos permite que algunos animales accedan a ellos excluyendo a otros. Los individuos dominantes obtienen más recursos. En la mayoría de situaciones naturales se produce una combinación de ambos tipos de competición, pudiéndose estimar separadamente (Van Hooff y Van Schaik, 1992).

Wrangham (1980) postuló que a menudo son los parientes los aliados más fiables a largo plazo en el seno de los grupos sociales de primates, de manera que habría una tendencia a permanecer en la sociedad natal o al menos migrar en conjunto con los parientes. Por ello, estos modelos sociales se basaron en especies de primates con grupos formados por hembras emparentadas. La excepcionalidad de los monos aulladores de manto radica en el hecho de que no sólo los machos que alcanzan la madurez sexual emigran de los grupos originales, sino que también las hembras abandonan el grupo individualmente y se incorporan a otros grupos sólo cuando pueden convertirse en dominantes de los inte-