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1 **Sharing your snack: unusual observation of a chick-chick feeding**  
2 **occurrence in colonial king penguin (*Aptenodytes patagonicus*)**

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26 **Abstract**

27 King penguins (*Aptenodytes patagonicus*) are colonial seabirds presenting an extraordinary  
28 breeding cycle. Parents take over 14-mo to raise a single chick to independence, upon which  
29 fledglings depart at sea for more than a year. Juveniles often return to the colony within the  
30 three austral summers following departure, and before the age of first reproduction (around ca.  
31 5-6 years old.), possibly to acquire the essential skills involved in breeding. Little to nothing is  
32 known on the acquisition of parental behavior. Here, we report an anecdotal, yet highly  
33 unusual, observation of chick-chick feeding behavior in this species. The behavior is highly  
34 unusual in that two non-sibling chicks, not yet independent, and hatched at different times  
35 (early and late) of the same breeding season were observed, the older chick feeding the younger  
36 one. Whereas alloparental feeding is known to occur in this species, this is the first reported  
37 observation of a chick-chick feeding event. This unusual behavior raises the question of  
38 whether the early social environment plays a role in the acquisition of essential parenting skills  
39 in this species.

40

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42 **Keywords:** Allofeeding, chick feeding, food sharing, learning, parental care, penguin,  
43 seabird

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## 46        **1. Introduction**

47            Allofeeding, the act of feeding another individual, is common in many bird species  
48 (Silver, Andrews, & Ball, 1985). Between adults, it often occurs in the context of reproduction,  
49 where food sharing between partners is suggested as a strategy allowing to strengthen the pair  
50 bond (Lack, 1940; Smith, 1980; Mori et al., 2010), reduce the nutritional stress of the recipient  
51 (often the female) during critical periods such as egg-laying (Jing et al., 2009; Halley, Holmes,  
52 & Robinson, 2015), or allow social integration within flocks by reducing aggression in highly  
53 sociable species (e.g. Eurasian Siskins, *Carduelis spinus*; Senar, 1984). Allofeeding also occurs  
54 in the context of parental care, where individuals might feed offspring belonging to a parent,  
55 sibling, or unrelated conspecific (Stamps et al., 1985; Carlisle & Zahavi, 1986; Jouventin,  
56 Barbraud, & Rubin, 1995; Waite & Strickland, 1997; Kalishov, Zahavi, & Zahavi, 2005;  
57 Lecomte et al., 2006; Jing et al., 2009; Roulin et al., 2016; Ducouret et al., 2020; Ogino,  
58 Maldonado-Chaparro, & Farine, 2021). Such behavior may be selected because of the direct  
59 and indirect fitness benefits accrued to both (often, but not always, related) recipients and  
60 donors (Hatchwell, 2009; Lloyd et al., 2009; Meade et al., 2010; Ogino, Maldonado-Chaparro,  
61 & Farine, 2021).

62            In this short note, we report a singular observation of chick-chick feeding in a colonial  
63 seabird species, the king penguin (*Aptenodytes patagonicus*). King penguins are long-lived  
64 seabirds that breed in vast colonies of several thousand of pairs on small subantarctic islands  
65 during the Austral summer (Barbraud et al., 2020). Their breeding cycle is long and complex,  
66 as parents take over 14-mo to raise a single chick (Stonehouse, 1960; Weimerskirch, Stahl, &  
67 Jouventin, 1992). Because reproduction extends for over a year, successfully breeding adults  
68 in one year are constrained to breed later in the subsequent season. Thus, breeding occurs in  
69 two waves: early breeding is initiated in November, whereas late breeding is initiated around  
70 January-February, and it is rare that late breeders succeed (Weimerskirch, Stahl, & Jouventin,

71 1992; Stier et al., 2014). In early November, after the molt, early breeders gather in colonies  
72 for a period of courtship and mate choice of roughly 11 days, before copulation occurs and the  
73 female lays a single egg. The egg is rapidly passed to the male, which starts incubating it on its  
74 feet, against a specialized warm skin fold devoid of feathers, called the brood pouch. During  
75 this period, the female leaves for a 300-500 km foraging trip at sea (Bost et al., 1997) during  
76 which they target myctophid fish usually clustered around marine areas of high productivity  
77 such as the polar front (Guinet et al., 1997). Male and female parents will keep alternating  
78 incubation duties, until the egg hatches some 53 days later, usually by early January. This is  
79 about the time when late breeding birds start laying their single egg that will hatch round late  
80 March (Viblanco et al., 2014). After hatching, parents then alternate chick feeding duties at a  
81 high frequency until the start of the Austral winter in June. Adult penguins possess the unusual  
82 ability to conserve undigested, unspoiled food within their stomach, allowing to feed the chick  
83 when it hatches, or should the partner be delayed at sea (Gauthier-Clerc et al., 2000). During  
84 the Austral winter (June to September), chicks are then left to themselves as their parents move  
85 to more distant foraging grounds (Bost et al., 2004). During the winter, chicks cluster into  
86 groups called “crèches” which afford them some protection against predation by giant petrels  
87 (*Macronectes spp.*) (Le Bohec, Gauthier-Clerc, & Le Maho, 2005) and adverse weather  
88 conditions (Eichhorn et al., 2011). They are intermittently fed by their parents, and rely almost  
89 exclusively on body reserves during prolonged fasting periods to last throughout the winter  
90 (Cherel, Stahl, & Maho, 1987; Saraux et al., 2012). Chick feeding by the parents resume in  
91 September-October, the subsequent spring, where chicks fatten for an extra 2-3 months before  
92 molting and finally departing for their first journey at sea (Stonehouse, 1960; Weimerskirch,  
93 Stahl, & Jouventin, 1992).

94

## 95 **2. Study site and subjects**

96 **2.1. Study site**

97 The animals in this report were observed in the French Southern Territories (Southern Indian  
98 Ocean), on Possession Island, in the Crozet Archipelago (46°26'S, 51°52'E). Birds were  
99 monitored in the “Baie du Marin” colony, home to over 23,000 breeding pairs (Barbraud et al.,  
100 2020), and located close to a permanent research station.

101

102 **2.2. Animals observed**

103 During the 2019-20 breeding season, as part of various studies conducted in the framework of  
104 a long-term monitoring program on the behavior and ecophysiology of king penguin  
105 (ECONERGY 119 program of the French Polar Institute), regular behavioral scans were  
106 carried out each week between early December and early May 2020. Scan sampling was  
107 performed over 40-min periods, sampling the behavior of birds every minute, totaling over  
108 16800 min, or 280 h, of observation. The behavioral repertoire of king penguins is described  
109 in detail elsewhere (Stonehouse, 1960; Côté, 2000; Viblanc et al., 2011; Jouventin & Dobson,  
110 2018). Briefly, the typical behavior of adults on-land includes: sleeping and resting behavior,  
111 comfort behavior (stretching, preening, shaking, etc.), vocalizing, territorial aggression, and  
112 egg-chick care (includes turning the egg, feeding and preening the chick). In chicks, similar  
113 comfort, sleeping and resting, and vigilance behavior is observed. Vocalizing is directed mostly  
114 to the parent and consists in soliciting food. Chick behavior also includes aggressive behavior,  
115 mainly threats.

116

117 **3. Observation and discussion**

118 On the 16<sup>th</sup> of March 2020, we observed (and filmed) a chick-chick feeding event in king  
119 penguins (see Online Supplementary Materials). What was singular about this observation was  
120 that an older chick hatched earlier in the breeding season (around January) was observed

121 feeding a younger chick hatched later in the same breeding season (around March), shortly  
122 before the Austral winter. King penguins raise a single chick per reproductive attempt, so the  
123 two chicks were not siblings. During the entire observation, one adult king penguin was present  
124 in close proximity (contact with the chicks), though we had no information on whether this  
125 adult was the parent of either chick. However, following the observation, the older chick moved  
126 further away, and the adult took charge of the younger chick (AC, personal observation). The  
127 brooding pouch of the adult was markedly visible (video 0:10, 0:17, 0:25) suggesting it might  
128 indeed have been the parent of the smaller, not yet thermally independent, chick. The older  
129 chick displayed all of the typical behaviors displayed by breeding adults. Specifically, the older  
130 chick was seen (1) feeding the younger chick (video 0:00-0:07; Online Supplementary  
131 Material; Fig 1A); (2) behaving aggressively and territorially towards neighbors (video 0:15-  
132 0:18; Fig 1B); and (3) attempting to guide the younger chick on top of its feet, the typical  
133 breeding position of adults (video 0:26-0:33; 0:50-1:06; Fig 1C). Although older chicks are  
134 known to behave aggressively towards one another (Stonehouse 1960; Le Bohec et al. 2005),  
135 there is to our knowledge no published record of chicks behaving parentally towards other  
136 chicks in this species. It is quite possible that the feeding attempt was a successful one: both  
137 the young and older chick showed several swallowing movements following the feeding event,  
138 which is usually observed following a successful feeding attempt (video 0:04-0:07; Online  
139 Supplementary Material; Fig 2). In addition, it is interesting to note that the older chick  
140 attempted to guide the younger chick on top of its feet after the breeding adult had done so just  
141 before.

142 In penguins, allofeeding is rare but found across species. Anecdotal accounts have been  
143 reported between mates in chinstrap penguins (*Pygoscelis antarctica*; Mori et al., 2010), Adélie  
144 penguins (*Pygoscelis adeliae*; Yoda & Ropert-Coudert, 2002) and jackass penguins  
145 (*Spheniscus demersus*; Broni, 1983). In king penguins, allofeeding from adults to chicks is

146 relatively common (25% of cases over 280 adult feeders observed; Lecomte et al., 2006) and  
147 is mostly attributed to failed breeders who preferentially feed chicks raised by close neighbors  
148 at during the time of brooding.

149 To our knowledge, allofeeding between offspring in birds has so far only been  
150 documented in between related offspring of the same clutch (Stamps et al., 1985; Roulin et al.,  
151 2016; Ducouret et al., 2020). Most king penguins only raise a single chick every two years at  
152 best, and given that the two chicks in our observations were from the same breeding season, it  
153 seems unlikely they were closely related, though we cannot know for certain. Higher-than-  
154 expected relatedness has been observed between neighboring breeders in king penguin  
155 colonies, though this relatedness remains weak and restricted to particular areas of the colonies  
156 such as the colony centre (Cristofari et al., 2015). Nevertheless, the fact that chick-chick  
157 feeding behavior has been observed in species with ecologies and life histories as contrasted  
158 as budgerigars (*Melopsittacus undulatus*; Stamps et al., 1985), owls (*Tyto alba*; Roulin et al.,  
159 2016; Ducouret et al., 2020), and penguins (this paper), suggests that (1) this unusual behavior  
160 may have evolved several times independently; and (2) relatedness may not be the only factor  
161 influencing the evolution of helping behavior in birds.

162 Whether such chick-chick interactions occur frequently or not in king penguins is  
163 unknown. We have been working on this species for several decades, spent every year hundreds  
164 of hours of scan-sampling observations in the field, and yet have so far never encountered such  
165 behavior before. Thus, this behavior is likely rare. Yet, penguin colonies are massive  
166 assemblages of thousands of individuals (Barbraud et al., 2020), and our observations were  
167 short-lived (seconds). While it is likely that such observations are usually missed, and perhaps  
168 more frequent than thought. Regardless, this observation questions the benefits and  
169 adaptiveness of such behavior. If indeed food was transferred from the older to younger chick,  
170 this behavior might appear maladaptive since any energy loss for offspring before the Austral



171 winter is risky in the face of the strong energy constraints faced by chicks during prolonged  
172 (up to 5 months) fasting (Cherel, Stahl, & Maho, 1987). This would be especially the case if  
173 the donor was in poor body condition itself, since the marginal value of obtaining food depends  
174 on individual needs and/or condition. Unfortunately, we did not have information on chick  
175 body mass. However, our observation (see Online Supplementary Materials) did not suggest  
176 that the donor was in poor condition, at least visually (*i.e.*, the donor chick did not appear to be  
177 particularly lean or emaciated). Thus, an alternative explanation may be that imitating parental  
178 behavior from a young age primes offspring for future reproduction when sexual maturity is  
179 reached. This might be especially advantageous for chicks in good condition that can afford  
180 trading-off a small surplus of food for the acquisition of a behavior critical for future life-  
181 history stages. Some indication that social learning might be important in king penguins comes  
182 from data on the time spent in attendance of juvenile king penguins to their natal colonies  
183 before their first breeding attempt. After having fledged, juvenile king penguin will remain at  
184 sea for at least a full year, travelling large extents of the Southern Ocean (Orgeret et al., 2019),  
185 before returning to their natal colony (most birds return after two years; Saraux et al., 2011).  
186 Juveniles return to their natal colonies in part for molting, however, the time they spend on-  
187 land exceeds that necessary for molting only (Saraux et al., 2011). Since first reproductive  
188 attempts are thought to occur at 3 or 4 years old at the earliest (Barrat, 1976) and more generally  
189 around 6 years old (Weimerskirch, Stahl, & Jouventin, 1992), it is unclear why these animals  
190 remain on-land. One suggestion is that juveniles use this time to learn the complex ritualized  
191 displays of courtship, perhaps through observation/imitation, prior to engaging into active  
192 breeding themselves (Saraux et al., 2011). This would entail that those activities related to  
193 breeding (including courtship and potential care of the egg or offspring) could partly be under  
194 the influence of social learning in penguins.

195 Nonetheless, given the lack of other observations of this nature so far, it is not possible to  
196 currently conclude on the adaptive nature of this behavior. It could well be maladaptive since  
197 maladaptive behaviors should be counter selected, explaining their rare occurrence in nature.  
198 Thus, future studies will be needed to bridge the gap between anecdote and data, allowing us  
199 to determine whether this unusual observation has any role to play (or not) in the acquisition  
200 of essential parental skills in king penguins, and more generally, in seabirds.

201

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207

## 208 **References**

- 209 Barbraud, C., Delord, K., Bost, C.A., Chaigne, A., Marteau, C., & Weimerskirch, H. (2020).  
210 Population trends of penguins in the French Southern Territories– *Polar Biol.* 43: 835–  
211 850.
- 212 Barrat, A. (1976). Quelques aspects de la biologie et de l'écologie du manchot royal  
213 (*Aptenodytes patagonicus*) des îles Crozet– *CNFRA* 40: 107–147.
- 214 Bost, C., Charrassin, J., Clerquin, Y., Ropert-Coudert, Y., & Le Maho, Y. (2004).  
215 Exploitation of distant marginal ice zones by king penguins during winter– *Mar. Ecol.*  
216 *Prog. Ser.* 283: 293–297.
- 217 Bost, C.A., Georges, J.Y., Guinet, C., Cherel, Y., Pütz, K., Charrassin, J.B., Handrich, Y.,  
218 Zorn, T., Lage, J., & Le Maho, Y. (1997). Foraging habitat and food intake of satellite-  
219 tracked king penguins during the austral summer at Crozet Archipelago– *Mar. Ecol.*

220 Prog. Ser. 150: 21–33.

221 Broni, S.C. (1983). An apparent instance of courtship feeding in the jackass penguin  
222 *Spheniscus demersus*– *Cormorant* 11: 63–64.

223 Carlisle, T.R. & Zahavi, A. (1986). Helping at the nest, allofeeding and social status in  
224 immature arabian babblers– *Behav. Ecol. Sociobiol.* 18: 339–351.

225 Cherel, Y., Stahl, J.-C., & Maho, Y. Le (1987). Ecology and Physiology of Fasting in King  
226 Penguin Chicks– *Auk* 104: 254–262.

227 Côté, S.D. (2000). Aggressiveness in king penguins in relation to reproductive status and  
228 territory location– *Anim. Behav.* 59: 813–821.

229 Cristofari, R., Trucchi, E., Whittington, J.D., Vignetta, S., Gachot-Neveu, H., Stenseth, N.C.,  
230 Le Maho, Y., & Le Bohec, C. (2015). Spatial Heterogeneity as a Genetic Mixing  
231 Mechanism in Highly Philopatric Colonial Seabirds– *PLoS One* (D. Steinke, Ed.) 10:  
232 e0117981.

233 Ducouret, P., Romano, A., Dreiss, A.N., Marmaroli, P., Falourd, X., Bincteux, M., & Roulin,  
234 A. (2020). Elder Barn Owl Nestlings Flexibly Redistribute Parental Food according to  
235 Siblings' Need or in Return for Allopreening– *Am. Nat.* 196: 257–269.

236 Eichhorn, G., Groscolas, R., Le Glaunec, G., Parisel, C., Arnold, L., Medina, P., & Handrich,  
237 Y. (2011). Heterothermy in growing king penguins– *Nat. Commun.* 2: 435.

238 Gauthier-Clerc, M., Le Maho, Y., Clerquin, Y., Drault, S., & Handrich, Y. (2000). Penguin  
239 fathers preserve food for their chicks– *Nature* 408: 928–929.

240 Guinet, C., Koudil, M., Bost, C., Durbec, J., Georges, J., Mouchot, M., & Jouventin, P.  
241 (1997). Foraging behaviour of satellite-tracked king penguins in relation to sea-surface  
242 temperatures obtained by satellite telemetry at Crozet Archipelago, a study during three  
243 austral summers– *Mar. Ecol. Prog. Ser.* 150: 11–20.

244 Halley, M.R., Holmes, A.L., & Robinson, W.D. (2015). Biparental incubation and

245       allofeeding at nests of Sagebrush Brewer's Sparrows– J. F. Ornithol. 86: 153–162.

246 Hatchwell, B.J. (2009). The evolution of cooperative breeding in birds: kinship, dispersal and

247       life history– Philos. Trans. R. Soc. B Biol. Sci. 364: 3217–3227.

248 Jing, Y., Fang, Y., Strickland, D., Lu, N., & Sun, Y.-H. (2009). Alloparenting in the Rare

249       Sichuan Jay ( *Perisoreus Internigrans* )– Condor 111: 662–667.

250 Jouventin, P., Barbraud, C., & Rubin, M. (1995). Adoption in the emperor penguin,

251       *Aptenodytes forsteri*– Anim. Behav. 50: 1023–1029.

252 Jouventin, P. & Dobson, S.F. (2018). Why penguins communicate: the evolution of visual

253       and vocal signals. Academic Press, London, U.K.

254 Kalishov, A., Zahavi, A., & Zahavi, A. (2005). Allofeeding in Arabian Babblers (*Turdoides*

255       *squamiceps*)– J. Ornithol. 146: 141–150.

256 Lack, D. (1940). Courtship Feeding in Birds– Auk 57: 169–178.

257 Le Bohec, C., Gauthier-Clerc, M., & Le Maho, Y. (2005). The adaptive significance of

258       crèches in the king penguin– Anim. Behav. 70: 527–538.

259 Lecomte, N., Kuntz, G., Lambert, N., Gendner, J.-P., Handrich, Y., Le Maho, Y., & Bost, C.-

260       A. (2006). Alloparental feeding in the king penguin– Anim. Behav. 71: 457–462.

261 Lloyd, P., Andrew Taylor, W., du Plessis, M.A., & Martin, T.E. (2009). Females increase

262       reproductive investment in response to helper-mediated improvements in allo-feeding,

263       nest survival, nestling provisioning and post-fledging survival in the Karoo scrub-robin

264       *Cercotrichas coryphaeus*– J. Avian Biol. 40: 400–411.

265 Meade, J., Nam, K.-B., Beckerman, A.P., & Hatchwell, B.J. (2010). Consequences of 'load-

266       lightening' for future indirect fitness gains by helpers in a cooperatively breeding bird–

267       J. Anim. Ecol. 79: 529–537.

268 Mori, Y., Kokubun, N., Shin, H.-C., & Takahashi, A. (2010). An observation of between-

269       mates feeding behaviour in chick-guarding chinstrap penguins– Polar Biol. 33: 1437–

270 1438.

271 Ogino, M., Maldonado-Chaparro, A.A., & Farine, D.R. (2021). Drivers of alloparental  
272 provisioning of fledglings in a colonially breeding bird– *Behav. Ecol.* (M. Naguib, Ed.)  
273 32: 316–326.

274 Orgeret, F., Péron, C., Enstipp, M.R., Delord, K., Weimerskirch, H., & Bost, C.A. (2019).  
275 Exploration during early life: distribution, habitat and orientation preferences in juvenile  
276 king penguins– *Mov. Ecol.* 7: 29.

277 Roulin, A., Des Monstiers, B., Ifrid, E., Da Silva, A., Genzoni, E., & Dreiss, A.N. (2016).  
278 Reciprocal preening and food sharing in colour-polymorphic nestling barn owls– *J.*  
279 *Evol. Biol.* 29: 380–394.

280 Saraux, C., Friess, B., Le Maho, Y., & Le Bohec, C. (2012). Chick-provisioning strategies  
281 used by king penguins to adapt to a multiseasonal breeding cycle– *Anim. Behav.* 84:  
282 675–683.

283 Saraux, C., Viblanc, V.A., Hanuise, N., Le Maho, Y., & Le Bohec, C. (2011). Effects of  
284 Individual Pre-Fledging Traits and Environmental Conditions on Return Patterns in  
285 Juvenile King Penguins– *PLoS One* (S. Thrush, Ed.) 6: e20407.

286 Senar, J.C. (1984). Allofeeding in Eurasian Siskins (*Carduelis spinus*)– *Condor* 86: 213–214.

287 Silver, R., Andrews, H., & Ball, G.F. (1985). Parental Care in an Ecological Perspective: A  
288 Quantitative Analysis of Avian Subfamilies– *Am. Zool.* 25: 823–840.

289 Smith, S.M. (1980). Demand Behavior: A New Interpretation of Courtship Feeding– *Condor*  
290 82: 291.

291 Stamps, J., Clark, A., Arrowood, P., & Kus, B. (1985). Parent-offspring conflict in  
292 budgerigars– *Behaviour* 94: 1–39.

293 Stier, A., Viblanc, V.A., Massemin-Challet, S., Handrich, Y., Zahn, S., Rojas, E.R., Saraux,  
294 C., Le Vaillant, M., Prud’homme, O., Grosbellet, E., Robin, J.-P., Bize, P., & Criscuolo,

295 F. (2014). Starting with a handicap: phenotypic differences between early- and late-born  
296 king penguin chicks and their survival correlates– *Funct. Ecol.* (D. Costa, Ed.) 28: 601–  
297 611.

298 Stonehouse, B. (1960). The king penguin *Aptenodytes pataconica* of South Georgia– *Sci.*  
299 *Reports Falkl. Isl. Depend. Surv* 23: 1–81.

300 Viblanc, V.A., Mathien, A., Saraux, C., Viera, V.M., & Groscolas, R. (2011). It costs to be  
301 clean and fit: Energetics of comfort behavior in breeding-fasting penguins– *PLoS One* 6.  
302 Viblanc, V.A., Saraux, C., Malosse, N., & Groscolas, R. (2014). Energetic adjustments in  
303 freely breeding-fasting king penguins: Does colony density matter?– *Funct. Ecol.* 28.  
304 Viera, V.M., Viblanc, V.A., Filippi-Codaccioni, O., Côté, S.D., & Groscolas, R. (2011).  
305 Active territory defence at a low energy cost in a colonial seabird– *Anim. Behav.* 82.

306 Waite, T.A. & Strickland, D. (1997). Cooperative Breeding in Gray Jays: Philopatric  
307 Offspring Provision Juvenile Siblings– *Condor* 99: 523–525.

308 Weimerskirch, H, Stahl, J.C., & Jouventin, P. (1992). The breeding biology and population  
309 dynamics of king penguins (*Aptenodytes patagonica*) on the Crozet Islands– *Ibis* (Lond.  
310 1859). 134: 107–117.

311 Yoda, K. & Ropert-Coudert, Y. (2002). A short note on an Adélie penguin feeding its own  
312 mate– *Polar Biol.* 25: 868–869.

313

314

315 **Figures**



316

317 **Fig 1.** Early-born king penguin (*Aptenodytes patagonicus*) chick observed: (A) feeding a late-  
318 born king penguin chick on the 16<sup>th</sup> of March 2020; (B) displaying the typical territorial  
319 behavior of a breeding adult. The extend open bill towards neighbors is accompanied by a  
320 vocalization and is a territorial threat known as bill gapping (Côté, 2000; Viera et al., 2011);  
321 (C) attempting to guide the younger chick on top of its feet, the typical breeding position of  
322 adults, which brood young chicks on their feet in a specialized bare and highly vascularized  
323 skin flap called the brood pouch (Stonehouse, 1960).

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328 **Fig 2.** Swallowing sequence observed in the early-born king penguin chick, suggestive of a  
329 successful feeding attempt (see text).