Table A1. Random effects retained in the final models (shown as “+”) for von Bertalanffy, Gompertz, logistic, $U_4$ and Richards’s growth models in body mass, bill length, head length and tarsus length. $A$, $k$, $T_i$ and $d$ are the upper asymptote, maximum relative growth rate, age at the inflection point and shape parameter, respectively. Prior to model comparisons (based on AICc), we evaluated the significance of random effects using likelihood ratio tests, with non-significant random effects ($p > 0.05$) being discarded. NA: not applicable.

<table>
<thead>
<tr>
<th>Trait</th>
<th>Model</th>
<th>Random effects at the intercept</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$A$</td>
<td>$k$</td>
</tr>
<tr>
<td>Body mass</td>
<td>von Bertalanffy</td>
<td>+</td>
</tr>
<tr>
<td>Body mass</td>
<td>Gompertz</td>
<td>+</td>
</tr>
<tr>
<td>Body mass</td>
<td>Logistic</td>
<td>+</td>
</tr>
<tr>
<td>Body mass</td>
<td>$U_4$</td>
<td>+</td>
</tr>
<tr>
<td>Body mass</td>
<td>Richards</td>
<td>+</td>
</tr>
<tr>
<td>Bill length</td>
<td>von Bertalanffy</td>
<td>+</td>
</tr>
<tr>
<td>Bill length</td>
<td>Gompertz</td>
<td>+</td>
</tr>
<tr>
<td>Bill length</td>
<td>Logistic</td>
<td>+</td>
</tr>
<tr>
<td>Bill length</td>
<td>$U_4$</td>
<td>+</td>
</tr>
<tr>
<td>Bill length</td>
<td>Richards</td>
<td>+</td>
</tr>
<tr>
<td>Head length</td>
<td>von Bertalanffy</td>
<td>+</td>
</tr>
<tr>
<td>Head length</td>
<td>Gompertz</td>
<td>+</td>
</tr>
<tr>
<td>Head length</td>
<td>Logistic</td>
<td>+</td>
</tr>
<tr>
<td>Head length</td>
<td>$U_4$</td>
<td>+</td>
</tr>
<tr>
<td>Head length</td>
<td>Richards</td>
<td>+</td>
</tr>
<tr>
<td>Tarsus length</td>
<td>von Bertalanffy</td>
<td></td>
</tr>
<tr>
<td>Tarsus length</td>
<td>Gompertz</td>
<td></td>
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<tr>
<td>Tarsus length</td>
<td>Logistic</td>
<td></td>
</tr>
<tr>
<td>Tarsus length</td>
<td>$U_4$</td>
<td></td>
</tr>
<tr>
<td>Tarsus length</td>
<td>Richards</td>
<td></td>
</tr>
</tbody>
</table>
**Appendix 2.** R code for von Bertalanffy, Gompertz, logistic, $U_4$ and Richards’ growth models using the Unified parameterization proposed by Tjørve & Tjørve (2017).

```r
############################ Growth models #################################
############################ Parameterizations Ti-form #############################

# A = upper asymptote
# k = maximum relative growth rate
# Ti = age at the inflection point
# d = shape parameter
# t = Age of the chick

# Unified parameterizations in the Ti-form from Tjørve & Tjørve (2017),
# Ecological Modelling 359: 117-127.

# von Bertalanffy: $A'(1-((1/3)*exp(-(9/4)*k*(t-Ti))))^{3}$
# Model (9) in Tjørve & Tjørve (2017)

# Gompertz: $A'(exp(-exp(-exp(1)*k*(t-Ti))))$
# Model (7) in Tjørve & Tjørve (2017)

# Logistic: $A/(1+exp(-4*k*(t-Ti)))$
# Model (5) in Tjørve & Tjørve (2017)

# $U_4$: $A'(1+(3*exp(-4^(4/3)*k*(t-Ti))))^{(-1/3)}$
# Model (11) in Tjørve & Tjørve (2017)

# Richards: $A'(1+(d-1)*exp((-k*(t-Ti))/(d^(d/(1-d))))/(d'^(d/(1-d))))^{(1/(1-d))}$
# Model (3) in Tjørve & Tjørve (2017)

############################ Models on Instantaneous growth #############################
############################ Parameterizations Ti-form #############################

#### Equations were obtained as first derivatives of growth models ####

# von Bertalanffy:
# $(9/4)*A*k*(exp(-(9/4)*k*(t-Ti)))/(1-((1/3)*(exp(-(9/4)*k*(t-Ti))))^{2}$

# Gompertz:
# $exp(1)*A*k*(exp(-exp(1)*k*(t-Ti)))*exp(-exp(1)*k*(t-Ti))$

# Logistic:
# $4*A*k*(exp(-4*k*(t-Ti))/(1+exp(-4*k*(t-Ti))))^2$

# $U_4$:
# $(4^(4/3))*A*k*(exp(-4^(4/3)*k*(t-Ti)))*((1+3*exp(-4^(4/3)*k*(t-Ti))))^{(-4/3)}$

# Richards:
# $((1-d)/(d'^(d/(1-d))))*A*k*(exp(-k*(t-Ti)/(d'^(d/(1-d)))))*(1+(d-1)*exp(-k*(t-Ti)/(d'^(d/(1-d))))/(d'^(d/(1-d))))$
### Maximum absolute growth rate

# gmax = maximum absolute growth rate (gmax = A*k)

# Some examples
library(nlme)
RGM$t<-as.integer(RGM$t) # t is the age of the chick when measured
RGM$ID<-as.factor(RGM$ID) # Chick identity
RGM$BillLength<-as.numeric(RGM$BillLength) # Bill length data
RGM$BodyMass<-as.numeric(RGM$BodyMass) # Body mass data
RGM<-groupedData(BodyMass~t|ID,data=RGM) # Main structure as grouped data
VarFunc.Auto<-varPower(form=~fitted(.)) # Power variance function -for models in body mass exhibiting heteroscedasticity-

# Example of a Gompertz model in Bill length with random effects for A, k and Ti:
BL.G.1<-nlme(BillLength~A*(exp(-exp(-exp(1)*k*(t-Ti)))), fixed=list(A~1,k~1,Ti~1),
random=list(ID=pdDiag(A+k+Ti~1)),
data=RGM, start=c(A=66,k=0.022,Ti=12),
method="ML", na.action=na.pass)
summary(BL.G.1)
logLik(BL.G.1)

# Example of a Gompertz model in Bill length with random effects for A and Ti:
BL.G.2<-nlme(BillLength~A*(exp(-exp(-exp(1)*k*(t-Ti)))), fixed=list(A~1,k~1,Ti~1),
random=list(ID=pdDiag(A+Ti~1)),
data=RGM, start=c(A=66,k=0.022,Ti=12),
method="ML", na.action=na.pass)
summary(BL.G.2)
logLik(BL.G.2)

anova(BL.G.1,BL.G.2)

# Example of a Richards model in Body mass with a correction for heteroscedasticity and random effects for A and Ti:
BM.R<-nlme(BodyMass~A*(1+(d-1)*exp((-k*(t-Ti))/(d^(d/(1-d)))))^((1/(1-d))),
fixed=list(A~1,k~1,Ti~1,d~1),
random=list(ID=pdDiag(A+Ti~1)),
data=RGM, start=c(A=1866,k=0.043,Ti=17.2,d=1.55),
weights=VarFunc.Auto, method="ML", na.action=na.pass)
summary(BM.R)
logLik(BM.R)