Growth and plumage development of Pintail ducklings.

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The growth of Pintail ducklings raised in semi-captivity was measured, and their growth curves presented so as to provide a tool for determination of the age of Pintail ducklings. Significant differences exist between the measurements of male and female ducklings, but the overlap between values of the two sexes prevents accurate determination of the sex of Pintail ducklings from morphometric measurements alone. A reference table allowing precise determination of the age of Pintail ducklings from plumage characteristics is presented, which can be used when it is not possible to catch ducklings in the field.

Key Words : *Anas acuta*, growth, plumage development, determination of age, reference curves.

The study of the dynamics of wildlife populations requires monitoring of the growth and survival of juveniles, which is sometimes done by following the growth of young individuals from their birth in the wild. However, it is not always possible to undertake this type of study, especially in *Anatidae* which generally have dispersed cryptic nests difficult to locate in dense vegetation (eg Higgins *et al.* 1969; Andren 1991; Arnold *et al.* 1993). Studies of such species rely on the capture or observation of young individuals while they swim with their parents, and reference values from earlier works are used to determine their age and sex. Such reference values (either morphometric or based on plumage development) exist for some wildfowl species, and are based either on captive-bred birds (eg Mallard *Anas platyrhynchos*, O.N.C. 1982; Hawaiian Goose *Branta sandvicensis*, Hunter 1995; Canada Goose *Branta* *canadansis minima*, Sedinger 1986; Tufted Duck *Aythya fuligula*, Kear 1970; Blue Duck *Hymenolaimus malacorhynchos*, Pengelly & Kear 1970) or birds caught in the wild (eg Canvasback *Aythya valisineria*, Dzubin 1959).

Such reference values are lacking for Pintail *Anas acuta*, for which previous studies suggest an easy distinction between juveniles and adults (Duncan 1985; Esler & Grand 1994) but no data are available to determine precisely the age of ducklings in the field. These data may be needed in the near future, given long-term declines reported for breeding Pintail populations in the Palearctic (Perennou *et al.* 1994) and the need for population dynamics studies in this duck species.

The regular measurements of the growth of semi-captive Pintail ducklings provided:

i) reference values for several morphometric characters through the description of growth curves;

ii) a test for differences in these growth curves between sexes and years;

iii) a reference table of plumage development that will help determining the age of Pintail ducklings in the field when it is not practical to catch and measure them.

Methods

Birds and hatchery techniques

Data were collected at the Centre d'Etudes Biologiques de Chizé, western France, on 23 Pintails (11 males and 12 females) which were first-to-second generation offspring of birds caught in the wild. Ducks were kept in semi-captivity at the research station to carry out behavioural and physiological studies within the framework of a programme on the ecology of wintering dabbling ducks (eg. Guillemain *et al.* 1999). The 23 ducklings came from four different broods over three years (**Table 1**). The size and sex-ratio of each brood are indicated in **Table 1**.

After hatching, the ducklings were separated from adults and individually marked with plastic rings. They were placed indoors under a warming Elstein lamp for four to five days. Ducklings subsequently were moved outdoors during daylight hours when weather made it possible (ie. not on rainy or exceptionally cold days). After two weeks, they remained outside all the time, in a 150-m^2 fen within a 400-m^2 fenced area. The pen was moved as soon as the vegetation became noticeably depleted. Birds were fed *ad libitum* with duckling pellets (26.5% protein) until 15 days and subsequently with a blend of duck pellets (24% protein), broken maize and wheat. Holm & Scott (1954) found that food protein content for optimal Pintail duckling growth was 19%. In addition to poultry pellets, the ducklings could freely forage on terrestrial insects, chironomid larvae, vegetation and natural seeds, which is similar to the natural diet of free-living individuals (Sudgen 1973). It is therefore expected that the curves will reflect the growth of Pintail ducklings under very good conditions, ie when birds are not limited by food.

Measurements

Body mass was measured to the nearest 0.1g when ducklings were under one month of age, to the nearest 1g afterwards, in the afternoon at approximately the same time to minimise possible daily variations (Baldwin & Kendeigh 1938 and Blacke 1956 in: Weller 1957). Morphometric measurements were taken as proposed by the *Centre de Recherche sur la Biologie des Populations d'Oiseaux*, which co-ordinates bird ringing activities in France: wing length (from the carpal joint of the tip to the longest primary) was measured to the nearest 0.5 mm with a metal ruler while folding, straightening and flattening the wing. Tarsus (from the indentation at the tibio-tarsal joint to the extremity of the middle toe), bill length (or culmen, from bill tip to the first feathers), and bill width and height (at the nostrils) were measured to the nearest 0.1 mm with callipers.

On a daily basis, only body mass was measured in 1997. In 1998, measurements (weight and morphometry) were also taken daily. In 1999, ducklings were measured every two days until 32 days, and subsequently every three days until 98 days. The body mass of ducklings born in 1999 also was measured at 117 days and 10 months. Measurements were performed by two different observers, one for 1999 and one for 1997 and 1998 (**Table 1**).

Plumage

Following Lesage *et al.* (1996), plumage development was described by direct observation of ducklings while measuring them. For brood four, the date at which first sheaths and feathers appeared was noted for each individual (Pengelly & Kear 1970).

Statistical analyses

As a preliminary analysis, for each morphometric character non-linear regressions were fitted to the data. Among those with good model fits (R^2>0.9) the Gompertz equation was retained since it is the most commonly used for growth data, especially in wildfowl (Sudgen *et al.* 1981; Lightbody & Ankney 1984 in: Sedinger 1986; Sedinger 1986; MacInnes *et al.* 1989). A four-parameter Gompertz equation was first fitted to the data. The form of this equation was:

$$Y=y_0+a.\exp(-\exp(x-x_0)/b)$$

Non-significant parameters were deleted so as to obtain the most parsimonious model. In order to detect differences between male and female ducklings, the average residuals of the regression between a given morphometric parameter and age (both sexes combined) were calculated for each age over all individuals of a given sex, and compared with Mann-Whitney *U*-tests. This was done for the ducklings from brood four, which was the one with the most complete dataset and for which ducklings were followed for the longest period. If a difference was found between sexes for a given morphometric parameter, the age at which this difference appeared (Mann-Whitney *U*-tests) was determined. This threshold age of difference between sexes was assumed to be the first age after which measurements for males and females differed consistently at the 10% level in more than 90% of measurements. The 10% level was chosen because of limited numbers of ducklings measured, while the 90% level was used because there were some missing data (ducklings were not measured each day). Subsequently, for each morphometric parameter, growth curves were drawn for males and for females, using the data from brood four.

A 'brood effect' on growth rates can arise from differences between parents, brood size and/or hatching date (eg Lindholm *et al.* 1994; Cooch *et al.* 1991a; Loonen & van Duijn 1997). A 'year effect' can be due, even when parents and brood size are the same, to varying food availability and quality (Perret 1962 in: Sudgen 1973; Cooch *et al.* 1991b; Lindholm *et al.* 1994; Gadallah & Jefferies 1995; Loonen *et al.* 1997) and/or differences in weather (Cooch *et al.* 1991b; Lindholm *et al.* 1994; Cooke *et al.* 1995; Loonen *et al.* 1997). 'Brood effects' could not be tested since three of four broods (ie broods one, three and four) had the same parents, while the number of ducklings in brood two was too small for a statistical analysis. On the other hand, broods one, three and four were approximately of the same size (**Table 1**), which offered a good opportunity to test for the 'year effect' since parents were the same. The 'year effect' was assessed by comparing: (i) male body masses and morphometric parameters between 1998 (brood three) and 1999, during the first 30 days; (ii) female body masses between 1997 and 1999, during

Table 1. Description of the four Pintail broods.

Brood	Hatching date	Number of ducklings		Parents	Age of last measurement
		Males	Females		
1	15 May, 1997	2	5	Pair 1	73 days
2	12 May, 1998	0	2	Pair 2	49 days
3	15 May 1998	5	1	Pair 1	35 days
4	21 May 1999	4	4	Pair 1	98 days

the first 71 days (the same was subsequently done for females during the first 30 days, for consistency with male data). As above, Mann-Whitney *U*-tests were performed on average values of residuals.

Results

Growth curves

The mean weight at hatching (day 0) was 28.0g±0.4 SE, n=8; (**Table 2**). The greatest increase in weight occurred between the first and the fourth weeks, and after seven weeks the ducklings were 24 times heavier than at hatching (**Figure 1a**). A small loss of weight occurred between 52 and 63 days, which corresponded with the fledging period.

Tarsus length was 28.0mm±0.2SE, n=8 at hatching (**Table 2**), and increased rapidly during the first 12 days, reaching almost its full size when the ducklings were six weeks old, before they started to fly (**Figure 1b**).

Bill width was more developed at hatching than bill length and height (**Table 2**): the bill was 15.5mm±0.1SE, n=8 long at hatching, 8.5mm±0.1 SE, n=8 wide and 8.4mm±0.1SE, n=8 high, which represented 29.1%, 47.3% and 39.1% of the final size, respectively. Bill size (ie the three parameters) increased very rapidly during the first three weeks and the bill was almost fully grown at 40 days, except for length which still increased slightly even after fledging (**Figures 1d, 1e, 1f**).

The increase of wing length was highly correlated with plumage development (see below). No significant growth of the wing was noticed during the first week, and the increase was still very low during the second (**Figure 1c**). Subsequently, the wings grew fast until fledging.

Differences between sexes

On average, males were significantly heavier and larger than females: the residuals of the Gompertz non-linear regression between age and all the morphometric parameters were greater in male than in female ducklings, the difference being significant for all characters (Mann-Whitney *U*-tests: all $U \geq 1119.0$, all $P<0.0001$ except for wing length: $U=1093.5$, $P=0.001$). No significant differences were observed at hatching (**Table 2**). The appearance of the morphometric differences between sexes in the growth period were not consistent over all measurements: the age of first significant difference between males and females could be assessed only for tarsus length, wing length, bill length and bill width (**Table 3**).

Differences between years

The early body mass and the growth rate were the most affected by the year effect, rather than the absolute adult body mass: the residuals of the Gompertz non-linear regression between age and body mass were significantly greater for females of 1999

Table 2. Measurements of Pintal ducklings at hatching, fledging, post-fledging (98 days) and juvenile stages (10 months). Values are means ± SE computed over individuals from brood four, n=4 males and 4 females, except for bill length in females where n=3 at day 98.

	Hatching (day 0)	Fledging (day 53)	Post-fledging (day 98)	Juvenile (10 months)
Body Mass (g)				
Males	28.23±0.49	711.68±18.57	702.00±42.35	742.75±54.74
Females	27.83±0.69	642.50±16.33	686.75±16.33	714.25±12.33
U-test	*U*=10.00, *P*=0.56	*U*=16.00, *P*=0.02	*U*=16.00, *P*=0.02	
Tarsus (mm)				
Males	27.85±0.33	53.04±0.70	54.90±0.47	
Females	28.21±0.21	50.28±0.62	51.92±0.60	
U-test	*U*=10.00, *P*=0.56	*U*=16.00, *P*=0.02	*U*=8.00, *P*=1.00	
Wing (mm)				
Males	32.75±0.48	274.25±3.09	273.50±3.57	
Females	32.25±0.25	259.75±0.25	262.00±1.08	
U-test	*U*=10.50, *P*=0.41	*U*=16.00, *P*=0.02	*U*=16.00, *P*=0.02	
Bill length (mm)				
Males	15.48±0.10	50.12±0.43	50.90±0.52	
Females	15.58±0.18	46.80±0.43	48.12±0.15	
U-test	*U*=7.00, *P*=0.77	*U*-16.00, *P*=0.02	*U*=12.00, *P*=0.03	
Bill width (mm)				
Males	8.50±0.17	18.04±0.23	18.59±0.14	
Females	8.55±0.10	17.43±0.21	18.02±0.17	
U-test	*U*=7.00, *P*=0.77	*U*=14.00, *P*=0.08	*U*=15.00, *P*=0.04	
Bill height (mm)				
Males	8.33±0.15	19.83±0.17	20.28±0.28	
Females	8.55±0.24	18.84±0.77	19.76±0.18	
U-test	*U*=7.00, *P*=0.77	*U*=14.00, *P*=0.08	*U*=13.00, *P*=0.15	

than 1997 during the first 30 days (*U*=0.0, *P*=0.014), but this difference disappeared when the first 71 days were considered instead (*U*=4.0, *P*=0.142).

The body mass of males did not differ between 1998 and 1999 (based on the analysis of residuals for the first 30 days, all *U*≤4.0, all *P*≥0.142). The only significant differences for males between years were for bill width and tarsus length: male tarsus and bill width were larger in 1998 than in 1999

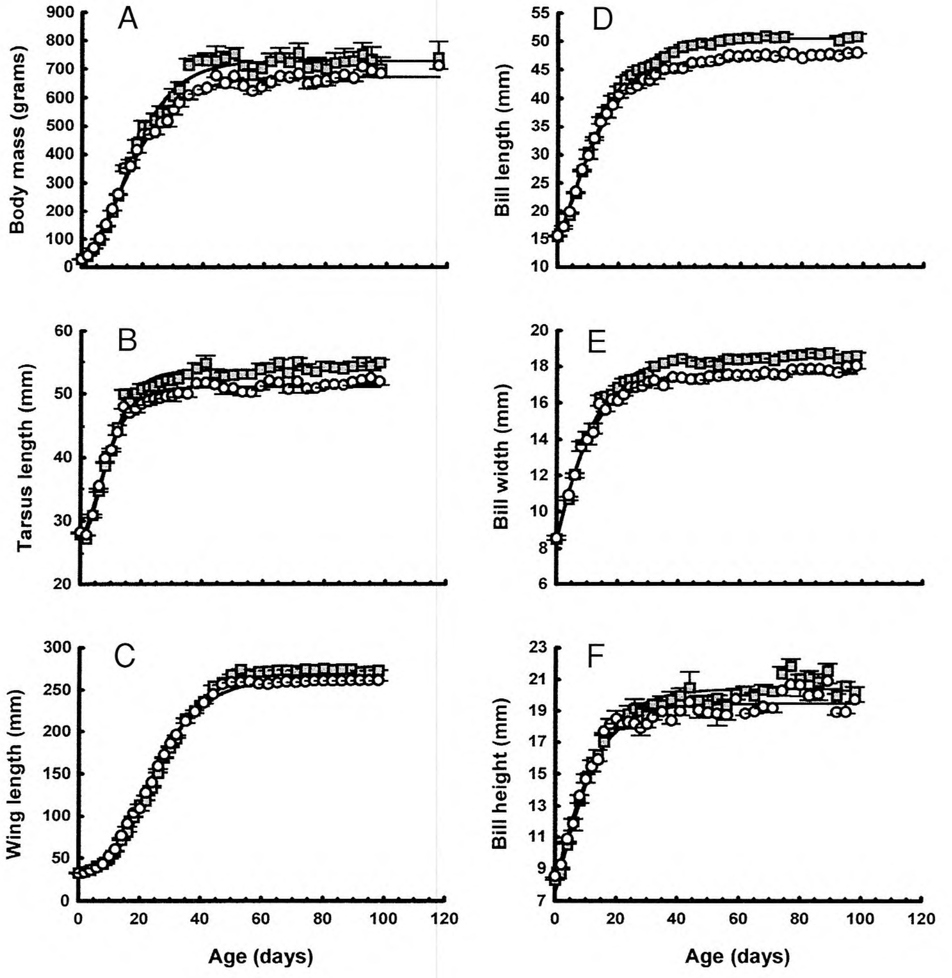

Figure 1. Growth of (A) Body mass, (B) Tarsus, (C) Wing, (D) Bill length, (E) Bill width and (F) Bill height in male (grey squares) and female (white circles) Pintails from hatching to 117 days (mean value from individuals of brood four (SD, n = four males and four females). Gompertz fits are indicated for each character in **Appendix 1**.

Table 3. Age at the first significant difference between average male and female Pintail measurements for the six morphometric characters. Average values (±SE, computed over individuals from brood four, n = four males and 4 females) of a given parameter at the age of first significant difference is indicated when relevant. The age at the first significant difference between sexes was defined as the age after which values differed consistently between males and females at the 10% level in more than 90% of cases (Mann-Whitney *U*-tests, n = four males and four females in each case). For each date after the threshold age (including it), each male-female comparisons were allocated to a significance level class. The number in each class for each parameter gives an idea of the robustness of our threshold age estimation.

	Age of 1st difference (days)	Value at age of 1st difference		Number of compairsons			
		Males	Females	$P>0.1$	$0.5<P<0.1$	$P<0.05$	Lacking
Body mass	still not different at 98 days	-	-	-	-	-	-
Tarsus length	18	50.1±1.1	47.7±1.1	3	3	24	0
Wing length	44	251.4±3.3	247.8±2.3	1	1	17	0
Bill length	24	43.5±0.6	42.7±0.7	0	1	21	5
Bill width	16	16.1±0.2	15.9±0.2	2	4	23	0
Bill height	still not different at 98 days	-	-	-	-	-	-

(U=19.0, P=0.027 and U=20.0, P=0.014, respectively; **Figure 2**).

Plumage development

The first sheaths to appear were those of the scapulars and under-wing coverts, at c.12 days (**Table 4**). Feathers appeared from the sheaths two days later on average, and were visible under the down. Sheaths of the rectrices appeared at the same age. The first remiges to appear were the secondaries, one day before the primaries during the third week. Tectrices appeared at the chin and the lore during the same week, as did sheaths of the upper tail coverts. During the fourth week tectrices developed on the head, throat, breast, belly and flanks, as well as primary and secondary coverts. At the age of one month the speculum was apparent, which allowed males to be distinguished from females. Five weeks after hatching feathers developed on the back and rump, as did the upper tail coverts and crural feathers. At the age of 52 days birds were able to make short flights, and the primary remiges of one wing were cut. The plumage of the whole head, neck and upper part of wings (ie coverts) was complete between 52 and 57 days, 10 days before the under-wing coverts. The plumage of the back was not complete before 11 weeks. The first plumage (juvenile appearance) was fully developed at approximately 110 days, an event marked by the emer-

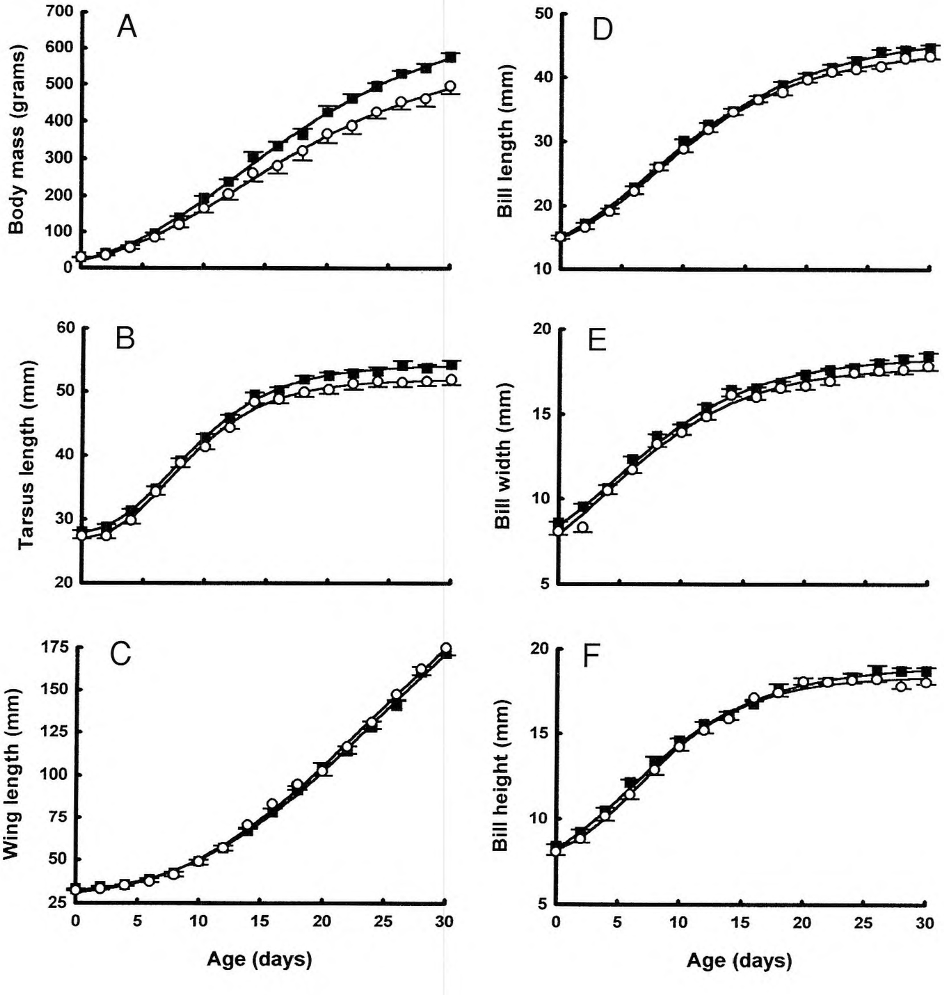

Figure 2. Growth of (A) Body mass, (B) Tarsus, (C) Wing, (D) Bill length, (E) Bill width and (F) Bill height in male (black squares) and female (white circles) Pintails from hatching to 30 days (mean value from individuals of all broods ± SD, n = four males and four females). Gompertz fits are indicated for each character in **Appendix 1**.

gence of the last feathers of the belly.

The age at which most plumage characters appeared did not differ significantly between males and females, except scapulars, under-wing coverts and the sheaths of primary and secondary coverts which appeared sooner in females than in males (**Table 4**). Here again, though significantly different, male and female values overlapped.

Table 4. Plumage chronology of Pintail ducklings: the mean ages when each type of feathers appeared (± SD) were computed over all individuals of brood four, ie n=8.

Plumage characteristics	Age at Appearance (days)	Comparison between Sexes (Man-Witney *U* test)	Age at appearance	
			Males	Females
Sheaths of scapulars and under-wing covert	12±1	U=1.5, P=0.22		
Sheaths of rectrices	14±4	U=10.5, P=0.41		
Scapulars and under-wing coverts (feathers)	14±1	U=14.0, P=0.04	14±1	13±1
Sheaths of primary and secondary remiges	16±3	U=59.0, P=0.01	18±2	14±2
Tectrices of the chin and lore	18±1	U=25.0, P=0.53		
Primary and secondary remiges, tectrices of throat and breast (feathers)	22±2	U=70.0, P=0.10		
Sheaths of upper-tail coverts	22±1	U=10.0, P=0.32		
Tectrices of the head, belly and flanks (feathers)	22±1	U=73.0, P=0.35		
Primary and secondary coverts (feathers)	26±2	Lacking data		
Speculum and upper-tail coverts (feathers)	27±2	U=16.5, P=0.79		
Crural feathers, back and rump (feathers)	33±2	U=27.0, P=0.32		
Head and neck completely feathered	37±2	U=24.5, P=0.20		
FLEDGING	52±1			
Upper parts of wing completely feathered	55±2	U=4.0, P=0.08		
Under parts of wing completely feathered	64±4	U=4.5, P=0.30		
Back completely feathered	79±3	U=9.5, P=0.20		
JUVENILE PLUMAGE COMPLETED	Approx. 110 days			

Discussion

Growth curves

Body mass

Body mass growth was very fast between one week and one month, then body mass declined temporarily until six weeks, ie one to three weeks before fledging, and subsequently reached a plateau corresponding to the adult weight (approximately at 55 days). The small decrease in weight before the fledging period has also been reported for Readhead (Weller 1957), Canada Goose (Sedinger 1986), Teal *Anas crecca*, Mallard, Gadwall *A. strepera*, Northern Shoveler *A. clypeata*, Common Pochard *Aythya ferina*, Ferruginous Duck *Aythya nyroca*, Tufted Duck, Cape Shoveler *A. smithi*, Cape Teal *A. capensis* and Mute Swan *Cygnus olor* (see review in Kear 1970). After seven weeks, the weight of Pintail ducklings was 24 times their mass at hatching, as noted by Southwick (1953 in: Kear 1970). During the same period body mass increased by a factor of 20 in Canvasback (Dzubin 1959) and a factor of 15 in Tufted Duck (Kear 1970).

At the end of the study period (ie 117 days) Pintails had reached their adult body mass. Values from this study are consistent with those provided for Pintail in the literature (eg 807g and 708g for males and females, respectively, Cramp 1977). A control weighing at the age of 10 months showed, however, significantly heavier weights for both males and females. This could be attributed to seasonal body mass variations which are common in dabbling ducks (Cramp 1977), or to the conditions of semi-captivity which minimise constraints.

Differences between years observed for the body mass of females are most likely to have been caused by differences in weather conditions (Cooch *et al.* 1991b; Lindholm *et al.* 1994; Loonen *et al.* 1997), since other confounding factors (ie parents, raising conditions and food) were controlled for. These differences were slight and did not affect body masses in the longer term, since the differences observed between years when considering the first 30 days disappeared when considering the first two months for the same individuals. If weather conditions affect the early growth rate of ducklings, they seem to be able to compensate, and reach the same adult mass even in 'bad' years.

Tarsus

The tarsus of Pintail ducklings was already well developed at hatching (51.4% of its final length), grew fast during the first 20 days, and reached its final size around 40 days. It is usual in waterfowl that the tarsus grows very quickly: Weller (1957); Dzubin (1959); Kear (1970) and Pengelly & Kear (1970) all found that in diving *Aythya* species the tarsus reaches its full length between six and eight weeks, which has been viewed as an adaptation for life on water (Kear 1970). In addition, since young ducklings are not able to fly, a rapid growth of the tarsus could also be a way of increasing diving and swimming ability, hence the chance of escaping predators.

Males born in 1998 had longer tarsus than males born in 1999, which might be due to a difference in the year, although the possibility of an observer effect cannot be excluded (observers differed between 1997-98 and 1999). However, year had a minor effect on age estimation after tarsus length measurement since, for the same tarsus length, the difference between the ages of males born in 1998 and 1999 only corresponds to 1.1 day±0.1SE, n=15.

Bill

The pattern of bill growth is very different for length, width and height. The bill, one of the earliest structures to develop in birds, is already well grown at hatching. Bill width had a slower relative growth than length in this study, as shown by Gille & Salomon (1999) in Pekin Duck *Anas platyrhynchos* f. *domestica* and Muscovy Duck *Cairina moshata* f. *domestica*. These authors suggested that the delayed growth of length vs. width resulted from a developmental constraint.

Males born in 1998 had slightly larger bills than males born in 1999, but other bill parameters did not differ. An observer effect also may be invoked to explain such inter-annual differences but, once again, year had a minor effect on age estimation after bill width measurement since, for the same bill width, the difference between the ages of males born in 1998 and 1999 only corresponds to 0.8 day±0.2 SE, n=18.

Wing

The wings are small at hatching (wing length only 13.1% of its adult size), but wing growth is very fast when primary remiges start to develop, after 10 days. At the age of 53 days, wing length of Pintail ducklings is 95.6% its final size, and birds start to make short flights. Kear (1970) also reported that Tufted Ducks were capable of short flights before the wings are fully grown. Wing length reached adult size at around 65 days.

Age and sex determination from morphometric measurements

Although the sample size was small (23 ducklings), the growth curves determined in this study can provide a tool for determination of the age of Pintail ducklings, which should be precise since the growth of all morphometric characters was rapid. The periods of fast growth do not occur at the same age for all characters. It is thus necessary to have several reference curves and to measure several characters to be able to determine ages of ducklings during their whole period of growth. Tarsus length and bill characters develop earlier, which allows precise age determination of very young ducklings, during their first two weeks of age (tarsus <50 mm, bill length <35 mm). Growth rates of these characters subsequently declines, while wing length and body mass continue to increase until 65 and 55 days, respectively, the age at which adult values are reached. The fact that wing length increases during a long period makes it a more convenient way of determining the age of pintail ducklings than body mass, although measurements of both characters would allow more precise age determination. Age determination after 65 days does not seem to be possible from the morphometric characters measured in this study.

Significant differences between males and females were observed quite soon in the growth period of pintail ducklings, but overlap was considerable. The present data do not allow to provide accurate keys to determine the sex of Pintail duckling from morphometric data. A larger data set might allow calculation of the probabilities of male and female measurements differing at each stage of growth, but the similarity between measurements of the two sexes suggests that considerable overlap would be found even with large samples. The colour of the speculum is the most reliable way of determining the sex of Pintail ducklings over 30 days of age.

Plumage development and determination of age at a distance

It is not always practical to catch ducklings for morphometric measurements. Plumage appearance can be a valuable source of information to determine their age, since there is no major difference between plumage growth in males and females. This study provides precise data on the date of appearance of the main feathers (summarised in **Appendix 2**), allowing a more accurate determination of age than previous references which gave a set of age classes (eg Gollop & Marshall, 1954 in: Sudgen 1973).

Plumage development occurs over a long period: the first feathers appear at the age of two weeks, and Pintail get their juvenile plumage between three and a half to four months.

Weller (1957) compiled data for the age of fledging in a variety of North American ducks, especially Pintail: 38-52 days in Hochbaun (1944), 42 days in Dzubin (1952) and 49 days in Stresemann (1940). This is sooner than Pintails in this study, which started flying at about 52 days of age. Lack (1968 in: Pengelly & Kear 1970) suggested that fledging periods are positively correlated with incubation periods. Thus Blue Duck have an incubation period of 31-32 days (Del Hoyo *et al.* 1992) and fledged between 70 and 77 days (Pengelly & Kear 1970), Mallards with an incubation period of 27-28 days (Del Hoyo *et al.* 1992) fledged around 63 days (O.N.C. 1982) and, consequently, Pintails with a 22-24 days incubation period (Del Hoyo *et al.* 1992) fledged at 50-52 days.

The rapid growth rate of Anatidae, in comparison to other precocial birds of similar size, has already been noted (Ricklefs 1973) and attributed to high seasonal food availability and short breeding seasons (eg Lesage & Gauthier 1997). The different morphometric characters do not grow at the same rate during the different development stages. As a consequence, no single character can be used to age birds between hatching and fledging, but a set of characters can provide precise age determination at any stage. Few studies have documented both morphometric measurements and plumage appearance in ducklings (Weller 1957; Kear 1970; Pengelly & Kear 1970; O.N.C. 1982), and this had never been done for the Northern Pintail. By presenting these two types of data, our study provides reference values that could be useful for future research involving age determination of *A. acuta* ducklings.

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Appendix 1. Parameters of Gompertz regressions for the ducklings.
1-117 days, see **Figure 1.**

		r^2	F	P	a	b	X_0	Y_0
Males	Body mass	0.9508	1528.35	<0.0001	731.22±6.18	9.46±0.47	12.31±0.35	
	Tarsus length	0.9655	1429.81	<0.0001	27.84±0.06	5.54±0.32	6.79±0.48	25.87±1.02
	Wing length	0.9945	9345.26	<0.0001	241.69±2.16	11.01±0.26	22.09±0.23	35.98±1.74
	Bill length	0.9918	8047.96	<0.0001	50.59±0.14	10.92±0.19	2.72±0.13	
	Bill width	0.9804	3763.53	<0.0001	18.46±0.04	9.19±0.21	-2.20±0.21	
	Bill height	0.9355	2235.94	<0.0001	20.43±0.10	9.58±0.32		
Females	Body Mass	0.9811	4110.18	<0.0001	673.84±3.41	10.14±0.29	11.52±0.21	
	Tarsus length	0.9566	1132.88	<0.0001	25.59±1.32	5.55±0.37	5.76±0.63	25.50±1.29
	Wing length	0.9963	13977.38	<0.0001	229.47±1.71	10.57±0.20	20.47±0.19	34.68±1.42
	Bill length	0.9866	5056.60	<0.0001	47.38±0.15	10.40±0.23	1.80±0.16	
	Bill width	0.9655	2114.72	<0.0001	17.60±0.04	8.75±0.26	-284±0.28	
	Bill height	0.9268	976.88	<0.0001	19.49±0.10	8.94±0.43	-1.12±0.38	

1-30 days, see **Figure 2**.

		r^2	F	P	a	b	X_0	Y_0
Males	Body mass	0.9580	1988.50	<0.0001	689.73±26.40	10.13±0.64	12.64±0.51	
	Tarsus length	0.9600	1137.04	<0.0001	6.41±0.81	4.55±0.31	7.25±0.29	27.72±0.64
	Wing length	0.9652	1315.16	<0.0001	287.82±55.41	14.89±2.48	24.99±2.71	30.97±2.81
	Bill length	0.9774	2051.17	<0.0001	34.61±1.92	7.85±0.58	7.07±0.59	12.01±1.44
	Bill width	0.9697	1464.40	<0.0001	11.25±0.77	6.24±0.47	4.70±0.72	7.06±0.68
	Bill height	0.9560	1031.70	<0.0001	11.97±0.88	6.31±0.58	5.52±0.76	7.09±0.75
Females	Body mass	0.8558	567.82	<0.0001	594.83±44.39	10.33±1.25	12.70±0.99	
	Tarsus length	0.9372	549.13	<0.0001	24.95±1.05	4.26±0.41	7.04±0.39	26.87±0.84
	Wing length	0.9562	809.26	<0.0001	285.76±66.90	14.76±3.19	24.17±3.24	29.21±3.92
	Bill length	0.9779	1638.78	<0.0001	31.43±1.59	6.97±0.52	7.33±0.51	13.01±1.20
	Bill width	0.9417	577.43	<0.0001	11.49±1.42	6.24±0.77	4.14±1.30	6.28±1.28
	Bill height	0.9538	758.39	<0.0001	10.78±0.58	5.28±0.48	6.29±0.52	7.69±0.48

Appendix 2. Key of plumage criteria allowing determination of the age of Pintail ducklings in the field.

1.	Scapulars non visible (only down):	UNDER 13 DAYS
	Scapulars visible:	→ 2
2.	Tectrices of the chin and lore non visible:	13-17 DAYS
	Tectrices of the chin and lore visible:	→ 3
3.	Primary and secondary remiges non visible, no throat and breast tectrices:	17-20 DAYS
	One of the above feather types visible:	→ 4
4.	Head, belly and flank tectrices non visible:	20-21 DAYS
	One of the above feather types visible:	→ 5
5.	Primary and secondary coverts non visible:	21-24 DAYS
	Either primary or secondary coverts visible:	→ 6
6.	Speculum and upper-tail coverts non visible:	24-25 DAYS
	Either speculum or upper-tail coverts visible:	→ 7
7.	Crural, back and rump feathers non visible:	25-31 DAYS
	One of the above feather types visible:	→ 8
8.	Head and neck only partially feathered:	31-35 DAYS
	Head and neck complete feathered:	→ 9
9.	Non-flying bird:	35-51 DAYS
	Bird capable of at least short flights:	→ 10
10.	Upper parts of wings only partially feathered:	51-53 DAYS
	Upper parts of wings completely feathered:	→ 11
11.	Back only partially feathered:	53-76 DAYS
	Back completed feathered:	→ 12
12.	Juvenile plumage not completed:	76-110 DAYS
	Juvenile plumage completed:	→ OVER 110 DAYS