THE GROWTH AND DEVELOPMENT OF THE SOUTH POLAR SKUA

(Catharatca maccormicki)

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This account is based upon work carried out at Cape Hallet, Antarctica, during the summers of 1958-59, 1959-60, 1960-61, with limited observations also in 1962-63.

METHODS

Eggs were weighed with a 0 - 200 gram spring balance and chicks with a 2Kg. beam balance accurate to 0.1 gm.

The methods used for measuring appendages were: *Bill length* — The standard chord of the culmen measured diagonally from the posterior of the culminicorn to the tip. *Gape Length* — A straight line from the angle of the closed gape to the tip of the culmen. *Tarsus length* — the diagonal measurement from behind the tibia metatarsal joint to the articulation of the middle toe with the metatarsus. *Toe length* — The dorsal length of the middle toe from its point of articulation to the tip of the claw. *Wing length (total)* — A straight line from the axilla to the tip of the farthest primary. *Wing length* (manus including primary feathers) — A straight line from the carpal joint to the tip of the longest primary. *Feather length* — The length of the shaft from follicle to tip. In all cases the length of the longest primary was taken.

During this study 542 weights were taken from 59 chicks of known age. A large sample was necessary because of the high mortality i.e. 18 (36 per cent.) of the 50 chicks weighed during their first week of life were dead by the end of that week. From another 29 chicks 117 sets of measurements were taken.

The work of the 1962-63 season primarily involved laboratory studies of embryological development, quantitative food requirement studies, growth correlated with nutrition, etc. A fire in late December destroyed the laboratory, equipment and all the records excepts some notes on the yolk sac and two sets of measurements.

THE NEWLY HATCHED CHICK

The incubation time was determined by adding one day to the number of days an egg was present. Data on 295 eggs showed incubation to extend from 26 to 33 days (mean 29.5 days; S.D = 1.058). Quite audible chirping may be heard in the egg three, and sometimes four, days before the chick hatches. The hatching process, from the first visible crack in the shell to its splitting in two, usually takes from 40 - 56 hours.

Eight chicks weighed within 15 minutes after hatching varied from 60.8 to 75.7 (mean 69.2) grams. The lightest chick came from a light egg weighing 88 gm. Egg weights for the other seven chicks are not known but the mean weight of 38 fresh eggs (weighed within 24 hours of laying) at Cape Hallett was 97.5 gm. This suggests that the weight of a chick at hatching is approximately 70% of the weight

of a fresh egg. The one example where both the egg and chick weights are known supports this weight relationship — 60.8 (chick weight) being 69% of 88.0 (egg weight).

The chicks hatch with a yolk reserve (table 1) adequate to sustain them for up to 72 hours. Starved newly-hatched chicks were often found dead on their third day. Five of these ranged in weight from 45.6 to 55.4 (mean 51.7) grams and so unfed chicks may lose approximately 25% of their initial weight before death.

Table 1 — Yolk Weight in Newly Hatched Chicks (Gms)

Chick Weight (Total)	Yolk Weight	Chick Weight (True)	Yolk % True Weight
72.1	7.3	64.8	11.3
69.8	6.5	63.3	10.3
64.0	6.7	57.3	11.7
68.6	6.8	61.8	11.1

Externally the ingested yolk-sac is seen as a conspicuous dome-like, oval yellow 'button' on the lower abdominal surface. In one chick (64 grams with 6.7 grams of yolk) it protruded six mm. and was 13 mm. in diameter, but it is usually smaller: the mean of eight chicks being 11 x 9 x 4 mm. It is still conspicuous on 7 - 10 day old chicks as a hardening flat, yellow scar approximately 11 x 4 mm. Usually by the seventeenth or eighteenth day the external remnant (a small, hard, dry, withered scar) is abscessed.

Newly hatched chicks dry at varying rates. They are still damp after three hours. By the sixth hour the down on the head, back and breast is often completely dry and becoming fluffy but the lower abdomen and around the cloaca is still slightly damp. Within 9 - 12 hours of hatching the chicks are totally dry.

The white horny egg tooth persists variably in different chicks. Usually it remains quite distinct for the first five to seven days, and then progressively disappears. It had completely gone on one five-and-a-half day old and three eight day old chicks but was still present (although reduced) on two 10 day old chicks. Normally there is no sign of it on chicks 12 days old, although at times the bill colour remains lighter at the egg-tooth spot for another four or five days.

After hatching and before being first fed two chicks from different nests lost 13 - 14% of their weight in the first 14 hours when living on their yolk-reserve. Both of these chicks were fed during their first day. Weights obtained show one was given its first two small feeds when between 15 and 24 hours old. Feeding was infrequent or else small portions were given during the next 40 hours as at 65 hours the chick was lighter than it was at 39 hours and it was also 12.5% lighter than it was at hatching. It picked up later, weighing 143 grams when seven days old. The other chick was first fed when between 15 - 19 hours old. It was then sustained at a low level and at 32 hours was 20% below its hatching weight. It was not very lively during this

weighing and was probably close to starvation. This chick was first fed substantially (i.e. 11.3 + gm given) when approximately 56 hours old.

PLUMAGE AND COLOUR

At hatching the wet chicks are a fairly dark bluish-grey in colour. Their blue shade is a product of the skin colour. As the down dries and becomes fluffy the chicks become a pale (often silvery) grey.

With development a gradual intensification in colouring occurs. The bill deepens from a shiny bluey-grey black to an intense lustrous black. The tarsus and toe likewise darken from blue-grey to black. The bill becomes black first (at about 23 - 26 days), then the webbing and toe (by about 40 days), and lastly the tarsus.

The teleoptiles are a medium slate grey when they first emerge. These gradually darken, more so on the back and wings than on the chest and belly until at eight or nine weeks the back and wings are blackish-grey while the chest and underparts have deepened to a smoky slate-grey. Thereafter the colour darkens more rapidly so that by the time the fledglings leave the breeding grounds (when about 12 weeks old) their heads, chests and underparts vary from a deep grey-brown to a rich chocolate brown while their wings and backs are a dark brownish-black.

The following descriptions are of different chicks.

Downy Chicks:

Six to twelve hours old (two chicks). Down light silvery grey. Bill, shiny greyish black, darkest around the egg-tooth. Tarsus, light blue-grey; webbing, light fawn-grey; claws, grey. Eyes brown; pupils, blue.

Thirty hours old (one chick). Down, pale grey but looks pale fawn or buff in some areas — as if the very tips of the down were lightly suffused with buff. Bill, shiny dark blue-grey except around the egg-tooth where darker and blackish. Tarsus, light blue-grey; webbing, light fawn-grey. Eyes, brown; pupils, blue.

Ten days old (one chick). Down, pale grey. Appearance of blue tinge due to underlying skin colour. Bill, blue-black except for tip (in front of egg-tooth) where it is blue-grey. Tarsus, medium to light blue-grey. Toes and webbing, medium to dark grey. Iris, brown; pupil, blue.

Seventeen to eighteen days old (two chicks). Down, light grey. Contour feathers on the back approximately 8 mm. long (sheath 6 - 7 mm. vane 1 - 2 mm.). Bill, almost black and lustrous. Tarsus, light blue-grey — but with patches of dark black-grey forming (70% blue-grey, 30% black-grey). Webbing, dark grey. Iris, brown; pupil, blue.

Fledglings:

Forty-five days old (two birds). Plumage; medium smoky grey. In one bird there was a barely perceptible brownish tinge. In both specimens colouring slightly more saturated on the head and back but very even. The white base of the primaries exposed but not as broad as on the adults (i.e. feathers not fully grown) and with less distinct margins. Back and head clear of down except for one or two very small tufts. More conspicuous down patches still clinging to legs and belly and under the tail. Bill has an even, smooth black lustre. Tarsus,

blackish — the underlying blue-grey representing 40 - 50% of the skin colour. Toes and webbing all black in one specimen but the other had an area one half inch in diameter on the webbing of each foot just at the base of the tarsus which was unpigmented, being a watery pink in colour.

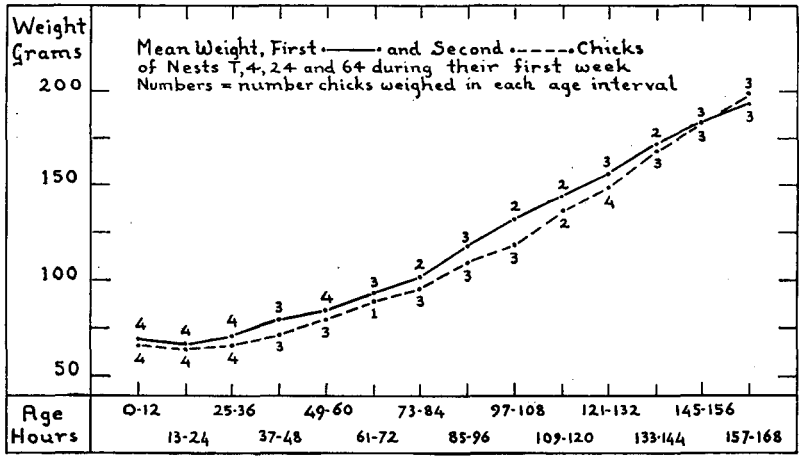
Sixty-three days old (one bird). Plumage; the head, neck, chest and belly are the same colour and degree of saturation. They are basically a warm dove-grey (Ridgway's Standard) with a faint suggestion of a brownish hue only apparent in certain lights. There is no fading of the feather tips. Colours of other specimens of a similar age range from warm dove-grey to smoky slate-grey on the belly and chest. The neck and chest are completely devoid of any yellow, straw or ochre streaks which are characteristic of adult *maccormicki* and which are also present on two-year (25 month) old birds. The back is a darker blackish-grey but the feather tips are less pigmented being a neutral grey. The feet and bill are not such an intense or lustrous black as in the adult and the tarsus is mottled with small patches of grey persisting.

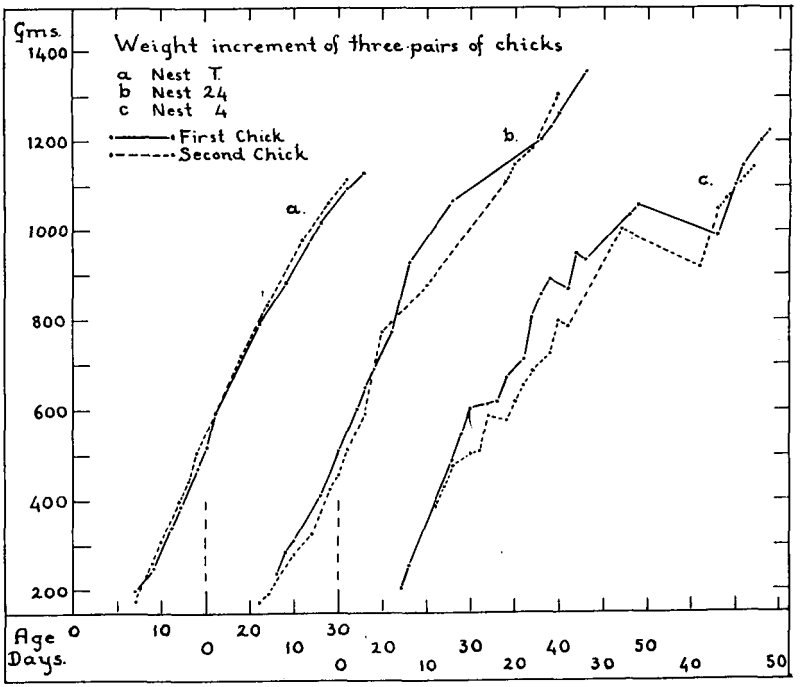
WEIGHTS

Young (1963a) draws attention to the limitations of weight as an index of growth. Skua chicks are often fed variable amounts at irregular intervals and weights obtained need not indicate the true relative or progressive size of chicks but merely that some have recently been fed.

In skuas the range in gross weight between well fed, "normal" and starved chicks of the same age indicates that throughout their development and particularly when nearing fledgling age the chicks can withstand a fast of several days. This ability helps reduce chick losses during some blizzards when the parents are not able to collect food.

Weights are summarised in *Appendix 1*. Chicks generally double their weight by the time they are 109 - 120 hours old and one did so in 97 - 102 hours. This chick only regained its hatching weight at 26 hours and therefore in fact doubled its weight in 71 - 76 hours.



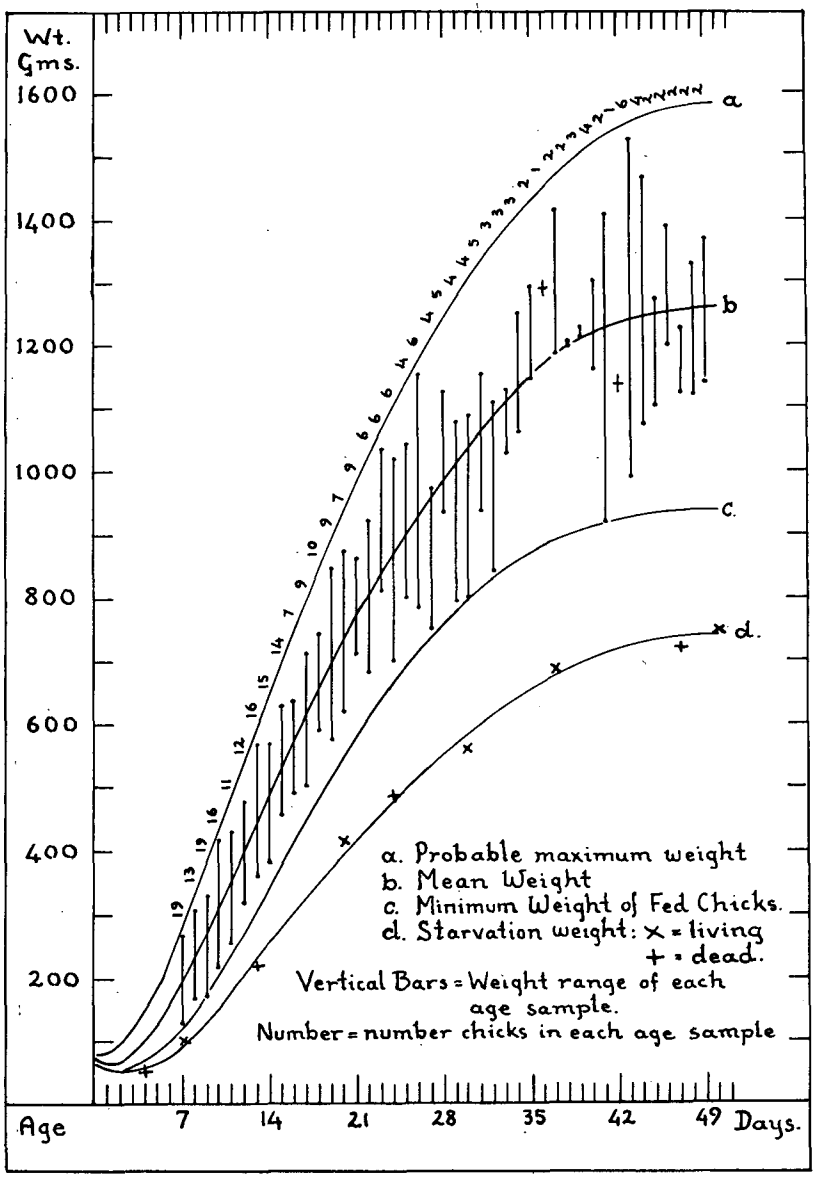


Even if emaciated specimens are excluded, there is a marked difference between heaviest and lightest fed chicks in each age group. The heaviest 55 - 60 hours old chick weighed 66 per cent. more than the lightest, and the heaviest 121 - 132 hour old chick was 52 per cent. heavier than the lightest in that age group. The greatest percentage weight increase in any given time period was 37% (41 gm) in 22 hours for a chick 100 hours old.

The mean daily increase in weight for first hatched and second hatched chicks from four nests during the first week of life is shown in *Figure 1*. At like ages these four first chicks were heavier than their younger siblings but in some other nests the younger chicks were heavier. Age for age the younger chick from one nest passed its sibling at 48 hours and remained the heavier until both were lost when approximately four weeks old. Likewise, the younger chick from another was 5.3 grams heavier than its sibling when both were 55 - 60 hours old.

Several pairs of chicks were weighed after their first week. Those from the three nests with the greatest number of weighings are shown in *Figure 2*. The chicks from these nests were tended by both parents (cp. Young 1963a, p. 222) and often fed together. This has given similar weight curves for the siblings in each nest.

In *Figure 3* the "probable maximum weight" curve is based on the assumption that with the large number of weights taken some chicks were probably in peak condition and also had nearly full stomachs. The "minimum weight curve of fed chicks" has been plotted along the lightest weights obtained from chicks which were either known to



live for another three days or were lively when handled. The "starved weight" curve is based on nine chicks; five living and four dead. The youngest chick contributing to this latter curve is the second chick from nest J which died towards the end of its third day. It weighed 45.6 grams and during its life had been continuously brooded but not

fed. The mean weight of fed chicks of like age (61 - 72 hours) is 90 (range 63 - 104) grams. The oldest starved chick was 50 days old weighing 730 grams. It did not respond to forced feeding and died. This chick's weight was 77% of the minimum weight of healthy chicks of the same age; 58% of their mean weight and 46% of their probable maximum weight.

Three other emaciated chicks were found. Their weights fitted approximately midway between the *c* and *d* curves in *Figure 3*. They were lost or killed before their weights dropped to the starvation threshold.

The weights of chicks at Cape Hallet substantiate Young's (1963a) observation that the later growth in rookery-fed chicks is less regular and they fail to attain the final weights reached by fish-fed chicks, the change being related to a change in the feeding habits of the adults. The mean weights of rookery-fed chicks at Cape Hallett between the ages of 35 - 50 days are strictly comparable with those of rookery-fed chicks of the same age at Cape Royds. However, as the following table shows, Cape Hallett chicks are significantly heavier during their first 30 days (Royds weights taken from Young's curve, p. 212).

Table 2 — Comparison Chick Weights: C. Hallett/C. Royds

Age Days	Cape Royds		Cape Hallet		Difference	
	Mean Wt.	No.	Mean Wt.	No.	Grams	Per Cent.
10	260	52	300	46	40	15.4
15	410	50	520	36	110	26.8
20	580	46	735	25	155	26.7
25	760	46	895	16	135	17.8
30	970	40	1045	13	75	7.7

No. = Number of chicks weighed

The heavier weight of Hallet chicks during their first 30 days is probably due in part to the extensive use of the station dump by these birds (i.e. the year's accumulative waste from the cookhouse) and in part to the greater natural food supply. (At Cape Hallett there were 345 breeding pairs of Adelie penguins to every pair of skuas compared with 265 pairs at Cape Royds (Taylor, 1962), (Young, 1963b) for every pair of skuas that lived almost exclusively on penguins).

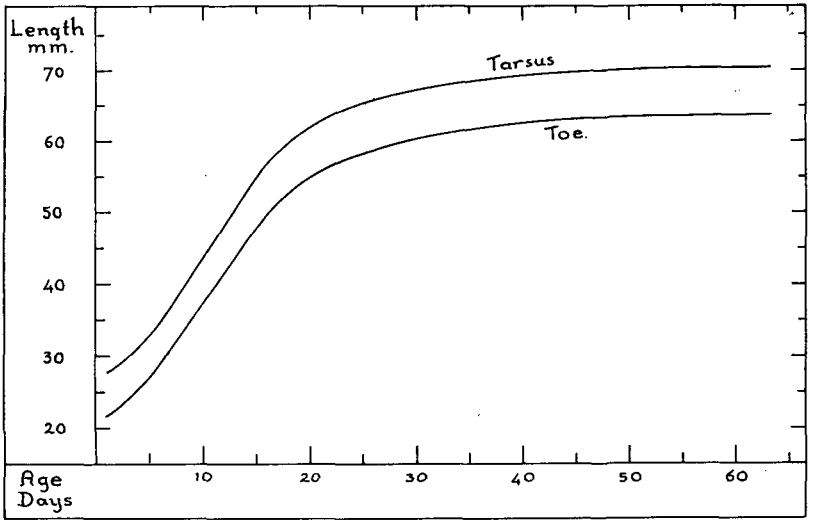
GROWTH (Appx. 2 and Figs. 4 - 7)

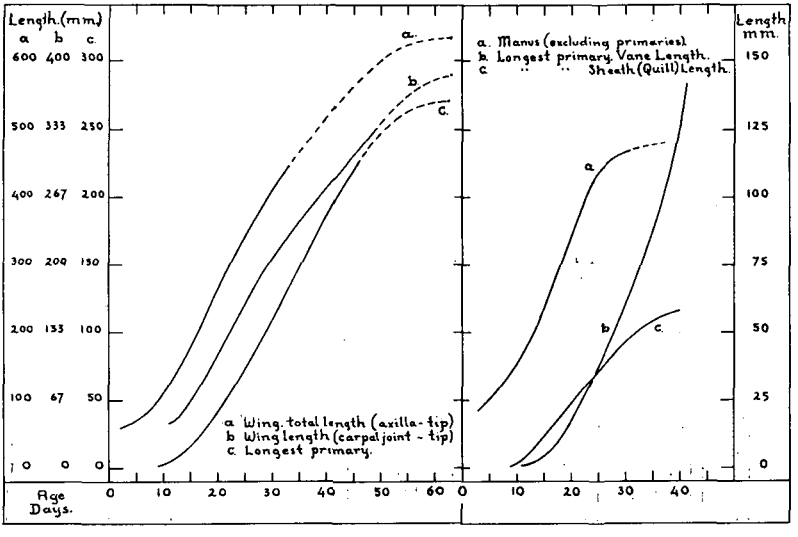
All measurements, except those for the 63-day-old fledgling, were of live chicks. They should enable future workers to determine the age of chicks to within two days.

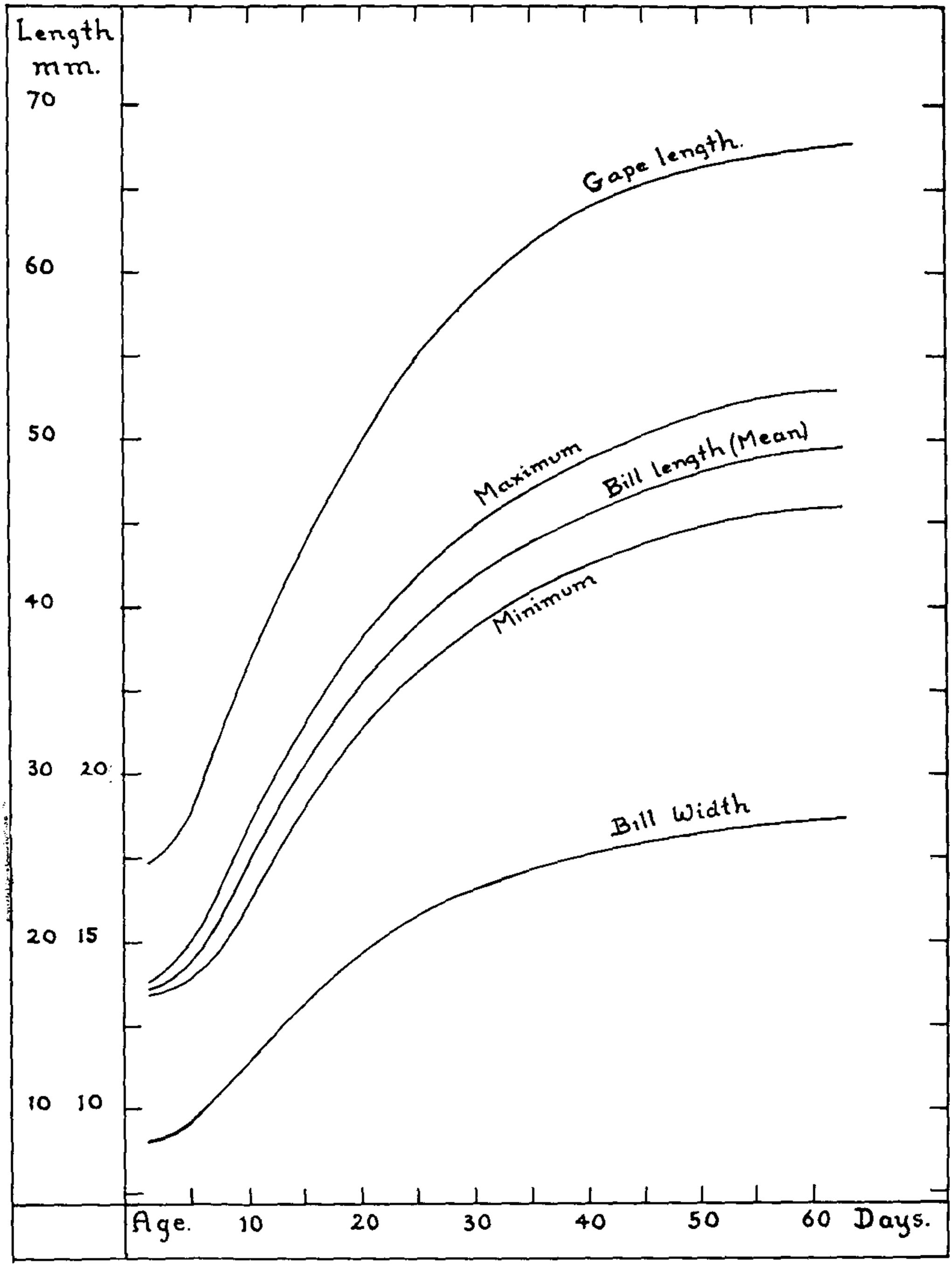
RELATIVE GROWTH RATE OF APPENDAGES

Feet (*Fig. 4*) attain maximum length earlier than wings (Fig. 5) or bill (Fig. 6). Tarsus and toe lengthen at an equal rate and reach adult size simultaneously. Growth is most rapid between the fifth and eighteenth day. During this two-week period the mean length increment of both tarsus and toe is approximately 1.5 mm. a day and

nearly 60 per cent. of the total growth is made. Growth continues for another 20 to 25 days, but at a slower rate, and adult dimensions are reached by about the 40 - 45th day. In reaching adult size the tarsus increases threefold and the toe lengthens two and one half times. Because of their similar growth curves the size difference of six mm. between the toe and tarsus remains unaltered from hatching to maturity.







The main growth of the manus takes place between the eleventh and twenty-fourth day. During this two-week period the manus lengthens by c. 64 mm., a mean growth rate of 4.5 mm. a day. Because of feather development it was not possible to measure the manus on chicks older than 31 days, but by this age growth was slowing down and (by extrapolation) the adult size of c. 125 mm. is probably reached by the 40 - 45th day. In growth pattern the long bones of the

wing appear to coincide with the bones of the manus in which the start of rapid elongation lags behind the legs by about six days. By the eleventh day when the wing bones are just starting fast growth the legs (based on the growth rate of tarsus and toe) are already half grown. Thus, growth is channelled to develop one locomotory system to an efficient level before the other. Early development of the wings would serve no purpose as function is dependent on feather growth.

FEATHER GROWTH

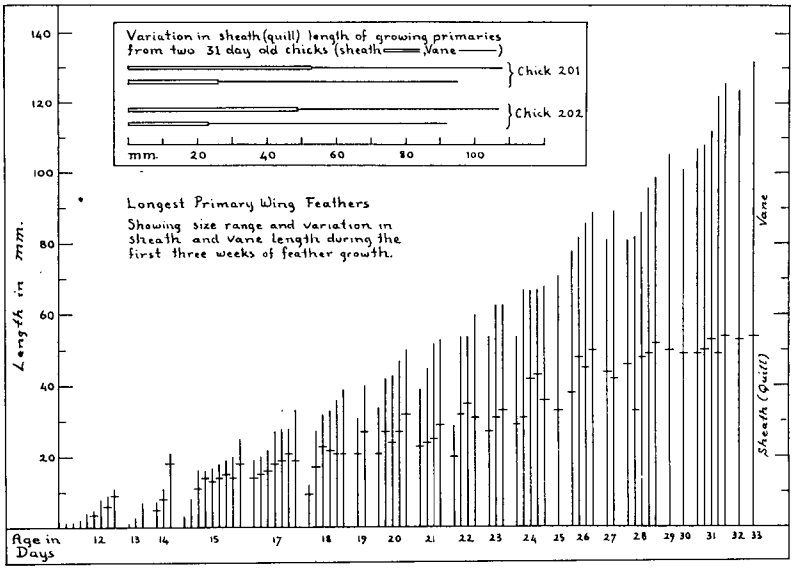
As it was not known whether primary feathers grew according to a strict pattern so that the relative length and growth rate of each feather maintained a constant relationship to the other feathers, measurements were made of the longest primary. This method was not followed by Young who sought to minimize variables by always measuring the same (i.e. seventh primary counting from the carpal joint outwards) feather. Both methods have advantages and limitations. Young's, being confined to a specific feather, is more precise, but it does not permit direct comparisons with adults where the standard measurement is from carpal joint to tip of longest primary.

Table 3 — Primary Feather Length

Age Days	Feather Length (m.m.)		Difference	
	C. Royds	C. Hallett	m.m.	per cent.
15	14	16	2	14.3
20	30	40	10	33.3
25	48	69	21	43.7
30	69	103	34	49.3
35	95	142	47	49.5
40	125	184	59	47.2
45	157	220	63	40.1

Primary feather cylinders first emerge from their follicles on the ninth or tenth day when they appear as minute stubs 0.5 mm. long. On the eleventh to thirteenth day when they are from 3 - 7 mm. long the protective outer sheath ruptures to expose the tip of the vane. Young (1963) observed that "for much of the growing period the quill lengthened more rapidly than the feathering was released, giving the feather a disproportionately long sheath." During the first 13 - 15 days of feather growth the sheath is usually longer than the vane but in 23 - 27 day-old chicks they are of equal length. From then on until adult size is reached the vane elongates more rapidly (Fig. 5). Measurements indicate that the most rapid growth of primaries commences around the seventeenth day when wing bones are half grown and the rate of leg growth has started to diminish.

Increase in wing length is brought about entirely by bone growth in the first ten days. Both bone and feather growth contribute during the next twenty days. At between 30 - 40 days growth is primarily attributable to the feathers and any increase in size after 40 - 45 days



is due solely to feather elongation. The most rapid lengthening of the wing is between the 15-30th days when both bone and feathers are growing rapidly. By about the thirtieth day bone growth has decreased (Fig. 5).

The proportion of vane to sheath varies appreciably in primary feathers of birds of the same age and on different feathers of the same bird (Fig. 7). *In 40-45 day-old chicks the white basal portion of the* primary vanes has emerged but the margin between the white and outer pigmented parts is not as sharply defined as in the adult. Contour feathers appear later than primary and secondary wing feathers.

BODY WEIGHT IN RELATION TO WING LENGTH

Weight increases more rapidly than the rate at which the wing lengthens, but extrapolation of the limited data indicates that the ratio of adult body weight to total wing length is attained around the fiftieth to fifty-third day. As fledglings are quite competent flyers at this age, muscular development keeps pace with appendage (i.e. bone) growth. Body size and wing length increase for about another week; the latter due solely to primary feather elongation. Therefore, fledglings are first capable of flight when the wings (axilla to tip) are 95 per cent. grown. At this stage primaries may be just over 90 per cent. of their full length.

BILL AND GAPE LENGTHS

During development the bill length increases threefold (i.e. from 17 to 50 mm.) and its width doubles (i.e. from 9 to 19 mm.). The most rapid lengthening occurs from the sixth to nineteenth day. During this two-week period nearly 50 per cent. of the growth is accomplished.

Increase of "gape length" closely parallels increase in bill length. In downy chicks the length of the bill is 70 per cent. and in adults 73 per cent. of the "gape length."

MOTOR CO-ORDINATION AND ACHIEVEMENT

No sooner had some newly-hatched chicks dried under their parent than they left the nest and when 12 - 24 hours old were frequently seen walking or squatting a few feet from the nest. This tendency to wander at an early age seems characteristic of the genus. Perry (1948) records a 24 hour old *skua* chick being three or four feet from the nest and Stonehouse (1956) mentions *lonnbergi* chicks running from the nest within a few hours of hatching. Early efforts at walking by first day *maccormicki* chicks resemble an ungainly shuffle. When standing their tarsi are but little inclined from the horizontal; thus the toes are placed well forward and are splayed apart giving a "knock-kneed" appearance. The chicks' belly is just above the ground and their centre of gravity well back so that the lightest lift on the lower bill topples them backwards. During walking the tarsi remain splayed and virtually horizontal and in contact with the ground. Imprints of a walking chick, one day old, left in a light film of snow showed the outlines of both tarsus and toe. During the first day the tarsus is used as an extension of the "foot" to give greater stability. This form of progression where, as the chicks shuffle along, the length of the pace is determined by the swing of the femur and tibio-tarsus, is probably due to an inability to hold the tarsus erect because of muscular weakness. Two-day-old chicks show a marked improvement in balance and increase in strength, and three- and four-day-old chicks (who are proficient walkers) were never observed to use the tarsus as an elongation of the "foot."

The age at which a chick first flew did not necessarily coincide with that at which it was first capable of flight, and fledglings were often reluctant to fly until a few days before their departure for the winter grounds. In general, flight is accomplished on, or about, the fiftieth day although some birds were not seen to leave the ground until approximately sixty days old. Young (1963) considers that the most important factor influencing the age of first flight is the size and siting of the territory, as chicks from large territories with gentle ridges flew earlier. At Cape Hallet, chicks from hill-side territories seemed to fly at an earlier age than those from the flat beach, and those from the north end of the beach (where the territories were larger) flew at a younger age than did chicks from the congested south end. Many of the territories in this congested area were very small and some chicks from these delayed flying until neighbouring territories were abandoned.

With the exception of occasional wing beating by stationary fledglings, pre-flying exercises were not noted.

Some fledglings were chased or harassed to determine at what age they could fly. Two 45-day-old fledglings ran with wings outstretched, but did not leave the ground. Another two ran, rose a few inches above the ground, flew for 10 - 12 feet and crash landed. A 47-day-old fledgling did not fly when hand-launched. When pursued it ran for 9 - 10 paces before becoming airborne. It flew for 20 - 25 feet without veering at a maximum ceiling of three feet and crash

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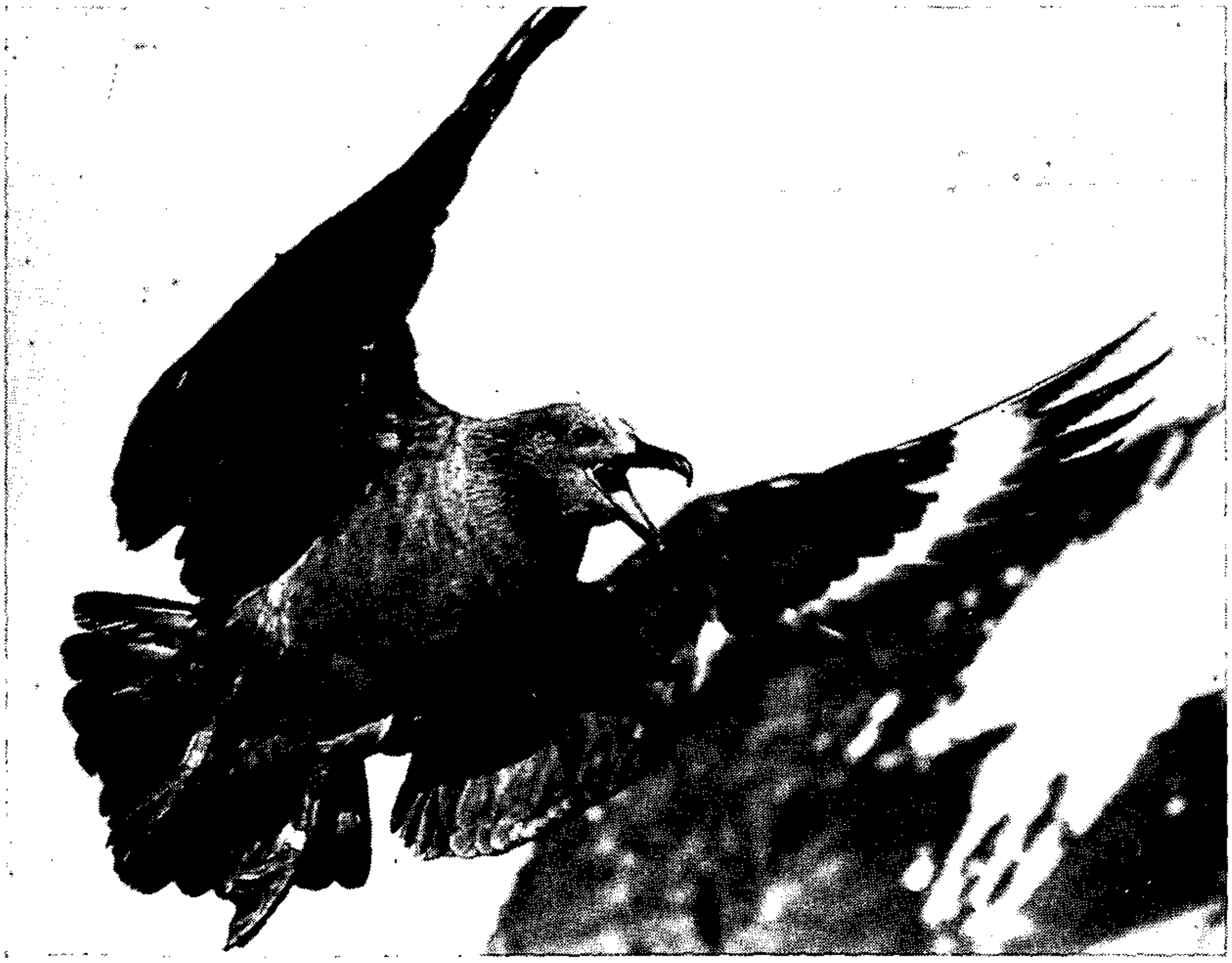
II — Nest 249, showing three chicks in the nest scrape. This pair successfully raised all three chicks, one of which was adopted.



[W. Bunker

III — **C. maccormicki** defending territory. The photographer was standing over the nest site.

landed. One 48-day-old fledgling skimmed eighteen inches above the ground in a straight course for 30 - 40 feet and then crash landed. Another flew over 50 feet, reached a ceiling of five feet on a curved course, and its landing was controlled. Two 49-day-old fledglings were accomplished fliers and expert at landing; a third landed imperfectly after flying for 40 - 50 feet at a maximum height of five feet. Two 50-day-old fledglings, when chased, circled and flew approximately 300 yards; another two flew 60 - 70 feet. All four displayed perfect co-ordination and balance when landing.

Young (1963a) gives the age of first flight for *maccormicki* as between 49 - 59 (mean 53.5) days. Perry (1948) records some *skua* fledglings flying as early as their forty-second day, and others not until their fifty-sixth day. He gives the average fledgling period as forty-six days. Stonehouse (1956) mentions one *lonnbergi* chick flying and landing inexpertly on the fifty-eighth day and another that was unable to gain height on its fifty-ninth day.

HABITS AND BEHAVIOUR

Some chicks are belligerent; others docile. Some are sedentarv and never wander far from the nest; others leave the nest on their first day and progressively cover a wider area. Some live in perfect accord with, while others bully and torment, their younger sibling. Some run when approached; others remain squatting. Some are easy to handle; others struggle incessantly.

WANDERING

Murphy (1963) writes "Newly-hatched chicks quarrel in the nest from the date of hatching; therefore they tend to separate from one another, as a result of which one of the two is sure to ramble outside the field of conscious parental protection, whereupon it is equally certain to be pounced upon and killed by a hungry neighbour or by its own deluded parent." This statement does not distinguish between voluntary wandering and being forcibly driven from the nest. The former is not linked with sibling friction, but is apparently a manifestation of an inherent exploratory drive. It is equally apparent in solitary chicks. Quarrelling between chicks is most noticeable during their first week, and upon being driven from the nest the younger sibling often follows its tormentor back to it without rambling further afield. Wandering in chicks does not stem from fighting.

Some chicks wandered on their first day. One-day and three-day-old siblings from one nest were found sitting nine inches apart 15 feet up a rough talus slope from their nest. Two chicks from another nest were first observed sitting together on their territory perimeter (over 40 feet from the nest) when the younger chick was two and a half days old. A five-day old single chick was ensconced on its parents' roost, a steep mound four feet high and forty feet from the nest. Its parents appeared confused at being displaced and walked in a stiff, hesitant manner around the base of the mound. Later in the day they were brooding the chick on the roost.

Many chicks had completely explored their territories (ranging in area from c. 100 - 30,000 sq. feet) by the time they were 7 - 10 days old, but it was unusual to find a chick of any age straying beyond the territory perimeter. A notable exception was an adopted chick which,

although accepted by its foster siblings, never associated with them, for they were sedentary, and it wandered far afield, being seen when 10 days old 115 feet from the nest on a rough talus slope.

Chicks appear to have an awareness of both the extent and shape of their territory. Straying beyond its limits sometimes occurred after a neighbouring territory had been deserted, or occasionally if the neighbouring pair were either submissive to the chick's parents or tolerant of its trespassing. Often it was necessary to chase chicks before being able to measure them and those in the congested part of the colony ran only a few feet before crouching. Two chicks, when chased, often ran the 150 foot length of their territory but upon reaching the margin turned back towards the centre. Likewise, most chicks when pursued went so far and then crouched or turned back. Generally, the turning or stopping point was also the outer margin of the adults' aerial territorial activities. However, chicks did not always need the adults' presence overhead or a vocal signal to warn them that they were at the territory margin.

Much of the chick's time is spent sitting and they usually remain so if approached quietly. When a few days old they often move about with head down pecking amongst the scree and moss like domestic poultry.

FIGHTING

Fighting between siblings, first noted by Wilson (1907) was seen in 13 (18.3 per cent.) of 71 nests in which both chicks lived for two or more days. In twelve the oldest chick was responsible, and all fighting occurred before it was eight days old. In each instance the younger chick was missing 24 - 48 hours after the fighting was seen. Friction is doubtless more widespread than my hurried daily rounds would indicate, but it is not universal. In three nests where both chicks fledged they were never known to quarrel during seven weeks, and although they wandered considerably, they frequently went in the same direction together.

Young (1963a) describes examples of friction and the parents' efforts to reduce this by separating the chicks. Successful segregation was not seen at Hallett where the adults appeared incapable of coping and never intervened.

Nests where fighting occurred were re-visited on the same day and at each a similar type and level of friction was seen as previously. This suggests that enmity between chicks is of some duration and although the range in intensity of fighting is very wide, the level of hostility of individual chicks to their younger siblings hardly varies.

In all cases fighting started in the nest scrape, and the intensity could be determined by a combination of the following conditions:

1. Fighting occurred under the brooding adult.
2. Fighting happened only after the attendant adult left the nest.
3. The older chick desisted after driving its sibling from the nest.
4. The older chick followed its sibling from the nest and continued to peck.
5. Pecking of the younger sibling, once started, continued without a break.
6. The older chick stopped pecking after knocking its sibling down.

Conditions 1, 4 and 5 which were seen in three nests combined to make the most intense friction, and a combination of conditions 2 and 6 (seen at two nests) comprised the mildest friction.

The younger chicks were never seen to fight back, and if knocked down would often crouch with the back of their head and neck vulnerable. When driven from the nest they frequently returned to it after a very brief interval, often before the adult had resumed brooding the older chick.

One of the thirteen records is unusual in that the siblings were 20 and 17 days old. and the younger chick attacked and broke the older chick's neck. These chicks had never been seen fighting previously and often kept fairly close company. I am indebted for the following account to Mr. M. Pryor:—

The younger chick which had two superficial wounds was standing 45 feet from the nest. The parents were beside the older chick who was sitting on the nest. The seventeen day old chick's wounds were examined. On being returned to the ground it ran and attacked its 20 day old sibling, killing it three feet from the nest in a fight lasting less than a minute. The parents stood silently and watched. One parent nudged the dead chick; it twitched and the parent stepped back. A third nudge elicited no response and the parent dragged the dead chick 9 - 10 feet away from the nest. Here both parents very deliberately but rather daintily plucked the down from the chick's breast, then peeled the skin off in strips, most of which were offered to the victor. After accepting these it joined its parents and all three devoured the corpse.

POSTURES AND CALLS

The stooped or crouched posture of chicks when walking, standing or sitting contrasts with the erect, head high stance of adults. During their first three or four weeks chicks keep their wings fairly closely folded against the body, but when approximately one month old the wings are more loosely held and droop slightly, body, neck and head are horizontal and shoulders are bowed forward, giving the developing chick a somewhat hunched and furtive appearance. If chased, half grown birds almost fully extend their wings, but as they are often unable to maintain balance at speed, they skew and topple. Chicks of about 40 - 45 days frequently walk with wings loosely folded or partially extended. When running they fully extend and flap their wings and do not lose balance. Pursued chicks of pre-flight age will often suddenly stop running and crouch.

Begging may be entirely vocal or it may be accompanied by small jumps in which the young bird extends its wings obliquely. The begging sequence of a 53 day old fledgling is described below.

The parents were foraging at the rubbish tip, 500 yards away. The chick was sitting quietly sixty yards north of its territory. It started giving many shrill tremulous whistles, each lasting for two or three seconds at one- to two-second intervals. (This differs from younger chicks which emit a series of longish quavery cheeps.) After a short period the fledgling stood, then paced and finally jumped.

Nine minutes elapsed between the first call and the parent's return. She landed some twenty-five feet from the chick which ran towards her with its back slightly humped, neck stretched horizontally forward, head inclined slightly downwards and wings partly extended and obliquely aligned. This wing position in which the radius-ulna is pointed obliquely upward, outward and forward, while the manus is pointed obliquely downward, outward and backwards adds to the fledgling's furtive appearance. With the wings in this position, the joint between the forearm and hand forms an apex level with the back of the chick's skull, but well above it, while the downward and backward alignment of the manus causes the outer primaries to lightly drag on the ground.

The continuous intense whistle and the little jumps in which the partially-extended wings display the white markings on the primaries probably helps the parent locate offspring which at this stage may be well away from the territory and be either alone or with other fledglings elsewhere.

In general, fully grown young stayed within the confines of the colony, but not necessarily within the limits of their own territories. They were seldom seen flying. On three occasions fledglings were seen foraging for themselves: two were pecking at dead penguin chicks in the Adelie rookery, and another was feeding with adults on waste from the cookhouse. However, in the main they seem dependent on their parents for food until departure for the winter grounds.

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Age Hours	No. Weighed 1st.	2nd	Sol.	Tot	Weights. Min	Max	Mean	3-Period Mean 1st.	2nd.	Sol.	All.
0-12	9	5	8	22	56·8	75·7	67·7	69·3	65·0	66·9	67·7
13-24	5	4	3	12	56·6	76·6	65·3	66·5	64·0	64·7	65·3
25-36	7	5	6	18	57·1	79·5	70·7	70·5	65·2	71·0	69·7
37-48	3	3	6	12	59·2	83·5	73·0	79·4	71·3	78·8	76·7
49-60	6	3	7	16	63·4	106	86·3	84·1	79·4	87·3	83·0
61-72	3	1	2	6	63·2	104	89·7	94·4	89·4	96·0	93·4
73-84	2	3	7	12	85·0	121	104·2	101·3	95·8	103·0	101·1
85-96	3	3	2	8	84·5	127	109·5	117·7	108·9	113·8	114·3
97-108	2	3	7	12	112	150	129·3	132·0	117·8	126·0	125·3
109-120	2	2	2	6	122	151	137·2	144·0	136·3	147·8	141·2
121-132	3	4	3	10	126	191	157·2	155·3	148·7	162·6	154·4
133-144	2	3	3	8	139	175	168·7	171·9	168·0	174·9	170·8
145-156	3	3	2	8	162	204	186·6	183·6	183·6	187·2	184·1
157-168	3	3	3	9	181	214	197·0	193·0	200·0	203·0	197·0

Age Days	No. Birds	Weights. Min.	Max.	Mean	3-P. Mean	Age Days	No. Birds	Weights Min.	Max.	Mean	3-P. Mean
8	13	166	309	239	229	29	4	796	1080	994	1011
9	19	156	332	252	264	30	4	802	1090	996	1015
10	16	219	419	302	297	31	5	939	1156	1054	1021
11	11	256	430	336	346	32	3	842	1109	1012	1043
12	12	319	477	400	400	33	3	1028	1130	1063	1072
13	16	362	568	453	444	34	3	1060	1253	1141	1141
14	15	380	569	478	486	35	3	1145	1296	1220	1217
15	14	458	630	528	519	36	1			1290	1271
16	7	492	637	551	568	37	2	1186	1418	1302	1264
17	9	501	713	625	608	38	2	1200	1202	1201	1242
18	10	590	744	649	659	39	3	1215	1230	1223	1224
19	9	577	852	704	693	40	4	1160	1303	1249	1212
20	7	430	877	726	734	41	2	920	1410	1165	1183
21	9	711	865	771	773	42	1			1136	1184
22	6	683	924	822	829	43	6	989	1527	1251	1215
23	6	812	1037	895	863	44	4	1072	1466	1258	1232
24	6	699	1021	872	891	45	2	1102	1274	1188	1247
25	4	800	1043	905	896	46	2	1200	1390	1295	1219
26	6	785	1155	912	909	47	2	1123	1224	1173	1231
27	4	752	976	909	954	48	2	1121	1328	1225	1217
28	5	937	1127	1042	982	49	2	1140	1368	1254	1254

Age Days	No. Birds	Bill Length Mean	Min	Max	Bill Width (Mean)	Gape Length (Mean)	Tarsus Length Mean	Min	Max.	Toe Length (Mean)	Wing Length. Total (Mean)	Manus (Mean)	Manus incl. Primary Mean	Min	Max.	Longest Primary Mean	Min	Max.	Sheath (Mean)	Vane (Mean)
1	3	17·2	17·0	17·5	9·0	24·7	21·7	21·0	22·0	27·7										
2	4	17·5	17·3	17·8	9·3	25·2	22·6	22·0	23·0	28·7	58									
3	1	17·0	–	–	9·2	26·0	24·0			31·0	62	21·0								
5	2	18·8	18·0	19·6	9·5	27·5	26·5	26·0	27·0	32·5	70	25·0								
6	3	19·3	18·2	20·4	9·9	30·3	29·0	28·0	31·0	33·7	74	28·0								
7	1	21·0	–	–	10·5	32·0	32·5			37·0	81	30·0								
8	5	22·8	20·8	23·7	10·8	34·1	33·6	32·0	35·0	39·0	94	32·5								
9	3	24·1	23·5	24·5	11·4	36·2	35·7	34·0	37·0	40·7	105	36·0				0·5		1·0	0·5	
10	2	23·8	23·5	24·0	11·3	35·5	35·5	34·0	37·0	41·6	110	37·5				2·0	1·5	2·5	2·0	
11	2	26·7	25·2	28·2	11·8	38·5	40·0	38·0	42·0	46·0	128	41·0	43·0	38	47	4·7	2·5	7·0	3·2	1·5
12	8	27·4	26·0	29·5	12·3	39·6	41·9	37·0	45·0	47·8	135	43·5	45·7	40	53	5·3	3·0	10·0	4·4	0·9
13	3	27·5	25·2	30·2	12·5	40·0	42·3	39·0	44·0	48·7	142	46·5	51·0	44	58	8·2	6·5	10·0	6·6	1·6
14	3	30·0	28·8	31·8	12·9	42·7	46·3	45·0	48·0	52·0	164	52·5	59·0	54	68	13·0	8·0	16·0	10·3	2·7
15	9	30·5	27·9	32·2	13·2	43·3	48·9	46·0	51·0	55·1	175	60·0	68·2	52	75	16·0	9·0	23·0	12·2	3·8
17	7	32·2	31·0	35·0	13·9	46·4	51·4	50·0	54·0	58·3	209	68·5	83·9	70	97	25·0	18·0	32·0	17·3	7·7
18	6	33·8	31·4	35·6	14·1	47·5	53·7	51·0	56·0	60·5	227	74·5	92·7	68	103	30·0	17·0	39·0	19·0	11·0
19	2	34·8	34·3	35·2	14·6	47·0	54·0	54·0	54·0	61·0	247	83·0	107·0	104	110	35·5	31·0	40·0	24·0	11·5
20	5	35·6	34·4	36·8	14·8	50·0	55·2	53·0	58·0	62·0	262	84·5	112·5	101	117	43·0	34·0	49·0	26·2	16·8
21	4	35·8	33·5	38·0	14·8	51·2	54·8	53·0	58·0	62·0	271	88·5	118·5	105	130	47·5	40·0	53·0	25·5	22·0
22	4	36·9	35·3	37·7	15·5	51·0	57·2	55·0	60·0	64·2	290	96·0	129·2	98	145	54·0	47·0	60·0	29·0	25·0
23	3	38·2	36·0	39·5	15·6	53·7	58·0	56·0	60·0	64·7	310	104·0	146·6	145	150	60·0	54·0	64·0	30·3	29·7
24	4	37·9	36·5	39·5	15·6	53·6	57·5	57·0	58·0	66·2	330	107·5	153·5	142	162	64·5	56·0	68·0	35·1	29·4
25	1	40·1	–	–	15·5	55·0	58·0			65·0	348	106·0	165·0			71·0			33·0	38·0
26	4	39·4	36·8	40·8	16·2	56·2	59·2	58·0	60·0	67·0	365	112·0	174·4	165	187	82·0	76·0	87·0	41·0	41·0
27	2	41·3	39·5	43·2	15·9	57·5	59·0	57·0	61·0	67·5	372		187·5	180	195	82·5	80·0	85·0	37·0	45·5
28	5	39·3	37·2	41·6	16·4	56·0	57·4	54·0	61·0	66·0	381	114·0	184·0	172	198	89·0	79·0	98·0	40·2	48·8
29	1	43·4	–	–	16·0	59·5	58·0			68·0	396		205·0			106·0			50·0	56·0
30	1	43·0	–	–	16·7	60·0	61·0			67·0			208·0			104·0			49·0	55·0
31	5	41·0	38·5	44·3	17·0	58·5	59·0	57·0	63·0	66·3	425	118·0	212·6	202	226	109·0	97·0	126·0	43·4	65·6
32	1	44·2	–	–	16·9	61·5	61·0			69·0			230·0			124·0			53·0	71·0
33	1	42·8	–	–	17·0	59·0	60·0			67·0	435		226·0			132·0			54·0	78·0
36	1	44·0	–	–	17·4	60·0	62·0			69·0			244·0			156·0			61·0	95·0
40	1	45·7	–	–	17·6	64·0	61·5			67·5			280·0			187·0			58·0	129·0
41	2	46·5	46·2	46·9	17·3	63·5	63·0	62·0	64·0	71·0			276·0	270	282	190·0	178·0	202·0	49·0	141·0
43	3	44·5	43·5	45·5	17·7	62·0	61·7	61·0	62·0	68·0			288·0	273	298	208·0	196·0	218·0		
45	1	45·0	–	–	17·5	64·5	62·0			69·0			300·0			220·0				
46	2	45·8	44·0	47·6	18·3	65·0	64·0	63·0	65·0	70·0			310·0							
50	1	48·5	—	—	18·2	66·0	63·8			71·0										
53	1	47·9	—	—	18·6	68·0	65·3			73·0										
58	1	48·5	—	—	18·5	66·5	63·0			68·0										
63	1	50·0	—	—	18·8	68·5	64·0			70·0	632		386·0			258·0				