BREEDING BIOLOGY OF THE CALIFORNIA GULL

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The California Gull (*Larus californicus*) has been studied from several standpoints in recent years, particularly in the Great Salt Lake region of Utah. The general natural history has been presented by Beck (1942) and Behle (1957). Special studies are those on food habits by Greenhalgh (1952), on migration by Woodbury, Behle and Sugden (1946), Behle and Woodbury (1952), and Woodbury and Knight (1951), on the plumage cycle by Behle and Selander (1953), and on the annual reproductive cycle by Johnston (1956*a*, 1956*b*). Despite all this effort, certain phases of the early breeding biology had still not received the detailed attention that they merited. Hence in the spring and summer of 1954 the writers undertook an intensive study to help fill in gaps in the knowledge of the species.

The study was made at Farmington Bay, a waterfowl refuge located on the east side of Great Salt Lake, 12 to 15 miles north of Salt Lake City. Here several artificially constructed islands are used each year by the gulls as nesting sites. One of these measuring about 90×312 feet was selected as the particular study site. The island was visited nearly every day by one or the other or both of us throughout the nesting season. The first hundred nests to be constructed made up the sample used for analysis. However, these constituted only about one-fourth of the nests that ultimately were present on the island. Numbered metal tags were used to mark the nests. They were attached to heavy gauge wire pushed a foot into the ground so that the gulls could not dislodge the markers. Later as the vegetation grew, numbered stakes were placed in the vicinity of the nests. As the eggs were laid in the nests, they were numbered with a soft wax pencil for identification. All the eggs were measured and a sample was weighed. The young were banded with regulation bands and were weighed at intervals; their total lengths were measured in inches, and temperatures were taken with a fast-recording mercury thermometer. The nesting events and the fate of the eggs and young were recorded.

EGG LAYING AND INCUBATION

Time of nesting and egg laying.—California Gulls begin to arrive from their wintering grounds on the Pacific coast in late February and early March. In 1954 they started nesting earlier than usual. At the time of our first visit to the island on April 9 we found seven nests with ten eggs. One nest contained 3 eggs and another 2 eggs, while the remaining 5 eggs were located in 5 different nests. Probably the first egg was laid about April 5. Our second visit to the island was made on April 11. At this time 28 nests contained 36 eggs distributed as follows: 2 nests had 3 eggs, 4 nests had 2 eggs, 22 nests had one egg. By April 16, our sample of 100 nests had all been constructed and marked. They contained from one to 3 eggs. On April 23, egg-laying for the 100 nests was completed. On this date 93 nests had three eggs each and 7 had 2 eggs each, making a total of 293 eggs laid in the 100 nests.

A summary of the egg laying is given in table 1. The number of nests with one egg showed a steady increase from April 9 until the 13th, with a steady rate of decrease after this date until April 22. The number of nests with two eggs showed a similar rate of increase and decrease with April 16 having the largest number, namely 47 nests containing two eggs. The number of nests containing three eggs built up slowly, showing the greatest increase after April 13. Such nests continued to increase until April 23 which date marked the completion of the laying in our sample of 100 nests. The peak of egg laying for the group occurred on April 13 when an increase of 52 eggs was noted in a 24-hour period. From the 13th to the 16th an increase of 63 eggs occurred, but this was

over a 41-hour period. Egg laying continued on the island until approximately May 20. This was a full month after the 100 study nests had been marked and egg deposition in them completed.

Interval between deposition of eggs.—Unfortunately our work schedule was such that we could not visit the island at the same time every day. The dates and times of

Table 1

Summary of Egg Laying

Date	Time of observation	Number of nests with 1 egg	Number of nests with 2 eggs	Number of nests with 3 eggs	Total number of nests with eggs	Total number of eggs	Egg increase
April 9	3:00 p.m.	5	1	1	7	10	....
April 11	9:00 a.m.	22	4	2	28	36	26
April 12	3:00 p.m.	25	14	3	42	62	26
April 13	3:00 p.m.	55	22	5	82	114	52
April 15	8:00 a.m.	43	34	22	99	177	63
April 16	3:00 p.m.	20	47	33	100	213	36
April 17	9:00 a.m.	11	38	51	100	240	27
April 20	3:00 p.m.	2	12	86	100	284	42
April 22	8:00 a.m.	....	8	92	100	292	8
April 23	3:00 p.m.	....	7	93	100	293	1

our visits during the egg-laying period are shown in table 1. Each time we visited the island the number of eggs was recorded for each nest. Our data enabled us to determine the interval of laying on this daily basis between the first and second eggs for 83 nests, between the second and third eggs for 50 nests and that between the first and third eggs for 46 nests. The results are presented in table 2. If there was a question as to the date on which the egg was laid, that is, whether one or two days were involved, these nests were placed in a separate category. From one nest to another, the interval between the first and second eggs varied from 1 to 4 days. Of the total of 83 nests, 75 or 90.4 per cent had an interval of either "1 to 2," 2 or "2 to 3" days. In contrast, there were only 2 nests with an interval of one day, one with 3 days, 3 with "3 or 4" days and 2 nests

Table 2

Summary of Intervals between Egg Deposition in Clutches

Interval between eggs	Between eggs 1 and 2		Between eggs 2 and 3		Between eggs 1 and 3	
	No. nests	Per cent	No. nests	Per cent	No. nests	Per cent
1 day	2	2.40	2	4	....	....
1 or 2 days	16	19.27	7	14	....	....
2 days	37	44.57	27	54	....	....
2 or 3 days	22	26.50	12	24	....	....
3 days	1	1.24	....	....	2	4.35
3 or 4 days	3	3.62	1	2	....	....
4 days	2	2.40	1	2	24	52.18
4 or 5 days	....	....	....	....	15	32.61
5 days	....	....	....	....	1	2.17
5 or 6 days	....	....	....	....	1	2.17
6 days	....	....	....	....	2	4.35
7 days	....	....	....	....	1	2.17
Totals	83	100	50	100	46	100

with an interval of 4 days. The majority of the nests had a two-day interval, since 37 or 44.57 per cent showed this situation.

With regard to the lapse of time between layings of the second and third eggs, it will be noted in table 2 that a larger percentage of the nests had an interval of two days than any other interval. Many of those included in the "1 or 2 days" and "2 or 3 days" categories may well have had two days between layings. Since the majority of birds had a two-day interval between the first and second eggs and also between the second and third eggs, it should follow that the normal interval between the first and third eggs would be four days. In substantiation of this we have the following data. Of the 46 nests for which the interval of egg deposition was definitely ascertained, 24 nests or 52.18 per cent had a 4-day interval and 15 nests or 32.61 per cent were in the 4- or 5-day category, thus making a total of 39 nests or 84.79 per cent that showed either 4, or 4 or 5 days between the laying of the first and third eggs. Probably most of the 15 eggs in the 4- or 5-day category were actually laid at a 4-day interval. Two nests of the 46 had a 3-day interval and 5 had five days or longer between the first and third egg.

Clutch size.—Since 93 of the 100 nests had 3 eggs each and only 7 had 2 eggs, it would seem that the normal clutch size is 3 eggs, at least for the gulls in this region. Observations on other nests on the same island not included in the study sample and on nests on other islands also indicated that three eggs constitute the normal clutch. Only one nest out of approximately four hundred observed on the study island had more than three eggs. It contained four and there was serious doubt that the fourth egg belonged there since its pattern of markings and coloration were quite different from the other three which were all like one another.

The seven nests that did not have the normal complement of three eggs may have several explanations. They may simply indicate differences between individuals in egg-laying characteristics. Or perhaps three eggs were indeed laid in these nests but something happened subsequently to one egg in each case; an egg may have been removed by either the rightful owner or an intruding gull. We found no evidence, however, that this had happened. Possibly the females attached to these seven nests dropped their third eggs in the water surrounding the island when disturbed by our approach. Yet another explanation may be that the owners of these nests actually laid three eggs but that one was laid in another nest. In addition to the instance previously mentioned of a nest containing four eggs, one of which had different markings and color, we found several instances on other islands of odd eggs in nests where there were but three eggs. Such situations seemed to occur with greater frequency among the late nesters. Unfortunately we did not follow through on these nests to see if they would ultimately contain a set of four eggs made up of a presumed full complement of three laid by the rightful owner in addition to the supposedly foreign egg.

Except for the fact that these seven nests were among the first 100 constructed, another possible explanation would be time of arrival. This was suggested by observations on another island. On April 17, when we were there we found but four nests with eggs, whereas on the study island at the same date the 100 marked nests already contained 240 eggs. On May 23 this other island was again visited and it was ascertained that of the approximately 150 nests then on the island, four-fifths contained only two eggs. A few contained one egg and the rest had three eggs. Subsequent visits revealed that a third egg was not added in most of the nests that had had two.

This particular island with numerous two-egg clutches seemed to be less desirable as a nesting site than most of the other islands. It was located close to the main cross dyke of the refuge and so was more subject to disturbance by passing patrol cars. Furthermore it was not completely surrounded by water. It seemed that the other more favor-

ably located islands on the refuge were chosen by the early nesters, leaving this less desirable island for the late nesters and possibly at the same time the late arrivals. Bearing on this supposition are the findings of Johnson (1956*a*:138) for the California Gulls at Mono Lake, California. On May 30, 1953, he ascertained that in the majority of nests the clutch size was two. The gulls nested later at Mono Lake in 1953 than did our study sample at Farmington Bay in 1954. An alternative explanation in this case is that there is an average difference in clutch size from one region to another.

In pursuing this subject further we conducted several experiments on seven nests that were not part of the 100 marked nests, duplicating the procedures that Davis (1942:553) worked out for the Herring Gull (*Larus argentatus*). In each case the California Gulls laid a total of three eggs regardless of how many eggs were placed in the nest or how many were taken away. These results indicate that this species as well as the Herring Gull is a determinate egg layer, but more investigation should be done on this phase of the breeding biology of the California Gull. Johnston's finding (1956*b*: 212) that breeding adult California Gulls have three brood patches supports the conclusion that three eggs constitute the normal clutch.

Egg weights and measurements.—All the eggs in the sample were measured in millimeters. The longest egg laid was 73.2, the shortest 60.3. The widest egg was 49.9 and the narrowest 42.8. No definite relationship between length or width could be determined. There was no indication that the longest eggs were also the widest or the narrow-

Table 3

Egg Weights in Grams

Nest no.	Egg weights 1st egg	2nd egg	3rd egg	Nest no.	Egg weights 1st egg	2nd egg	3rd egg
3	70	71.2	....	76	76	77.3	71.4
7	72.5	72.4	74.5	77	78.5	78.4	70.9
8	71.2	71.6	....	82	72.7	73.8	64.9
11	79.4	71.3	79.3	84	69.4	77.8	69.2
15	76	78.2	74.2	86	65.2	65.6	63
22	65.8	71.2	69.1	89	64	69	62.4
29	80	76.7	77.3	90	76.7	73.5	76.3
44	71.8	74.3	71	91	70	69.2	65.2
46	76.4	75.4	69.4	93	77.3	78.2	....
48	79.4	79.4	76.1	94	71.2	71	70.6
60	71.6	70.3	66.2				

est. One item of possible significance is that the first two eggs were of essentially the same size whereas the third was slightly smaller. The averages for the three eggs were as follows: for the first egg, 66.5 by 46.7, for the second egg 66.7 by 46.7, and for the third egg 65.9 by 45.5. This size difference between the first two and the third egg in the clutch is corroborated by the weight data for fresh eggs in 21 nests. The average of the first egg laid was 73.1 grams, for the second egg 73.6 grams, but for the third egg 70.6 grams. This did not hold true in all cases, however, for there were some nests in which the third egg weighed as much as or more than the first or second egg. The average weight of the 60 eggs weighed was 72.7 grams. The heaviest egg weighed 80 grams, the lightest 62.4 grams. In the majority of nests the eggs were fairly uniform in weight but in a few instances differences of as much as 15 grams were found between eggs in the same clutch.

Incubation.—Considerable variation was found in the incubation period. Comparing the data for all the eggs, the longest periods of incubation recorded for the first, second

and third eggs were, respectively, 33, 31, and 26 days, while the shortest periods were 24, 22, and 21 days. The average incubation time for the first eggs was 26.7 days, for the second, 25 days and for the third, 23.6 days. Thus the incubation time of the third egg was less than that of the second which in turn was less than that of the first. Although the average situation seemed to be a two-day interval of deposition between the first and second eggs and between the second and third eggs, as previously noted, there was great variation in the intervals between hatching of the eggs within a clutch. While in the majority of cases the third egg is laid approximately two days after the second egg, it usually hatches within 24 to 36 hours after the first two eggs have hatched. Yet there are cases where three days intervened between the hatching of the second and third eggs and other instances where all three eggs hatched at about the same time.

This situation is probably tied in with the vagaries of heat application to the eggs. There is probably variation between adults in the time of commencement and the faithfulness of incubation. Just when continuous incubation by the adults starts was not ascertained. Incubation may be desultory until the full set of eggs is laid. Thus in those cases when all three eggs hatched at about the same time it may be that incubation did not begin until the third egg had been laid. From frequent changes in the position of the marks placed on the eggs to identify them, it was evident that there was considerable turning of eggs in the nest. We were not able to determine how or how often this was done. This may have been done haphazardly as a consequence of arranging the eggs to fit the brood patches, but more probably it was done at regular intervals.

Hatching and nesting success.—Hatching first began on May 4 when we found pipped eggs in two nests. The peak of the hatching period occurred on May 12 when an increase of 61 chicks in a 24-hour period was noted. All the eggs that hatched did so by May 19. Those eggs that were cracked one day would be pipped from one to two days later. Usually if the eggs were pipped upon one of our daily visits the chick would be fully hatched the next day. The length of time that it takes to emerge completely from the egg, as revealed by our observations at other nesting sites, varies greatly with individuals; it ranges from about half an hour at one extreme to several hours at the other. This seemed to be due primarily to the vigor of the movements of the chick but it may also have been correlated with the degree of thickness and hardness of the shell. Some California Gull eggs were found to be soft and thin and easily crushed while others were hard and thick.

Of the 293 eggs in the 100 nests, 254 or 86.7 per cent hatched. The fate of the other 39 eggs is as follows: nineteen simply disappeared soon after being laid. The only other birds seen on the island were two Canada Geese (*Branta canadensis*) and it is doubtful that they disturbed the eggs. Predaceous birds like crows and ravens are seldom seen on the refuge. Because of the surrounding water it is unlikely that any predaceous mammal or reptile visited the island. The site was not visited to our knowledge by other people. Only authorized personnel of the State Fish and Game Department were permitted on the refuge and they were aware of the study in progress. As a further precaution the study island was posted on both ends with "do-not-disturb" signs indicating that rerearch was in progress. The conclusion is, therefore, that the disappearance of the 19 eggs must be attributed to the gulls themselves. They may have been destroyed by marauding gulls but we saw no broken shells that would indicate this. More likely they were moved by the females that laid them and were not detected by us among the many unmarked nests on the island. They may have been rolled away from the original sites or carried in the buccal cavity. Experimentation showed that the mouth of an adult California Gull is extensive enough to enable it to engulf one of its own eggs.

Ten eggs were inadvertently broken in the course of the study. Three of these which

were very soft shelled were punctured by us as we were marking them. Four were fresh eggs smashed by adults in precipitous flight from their nests. Three others containing well developed embryos were found crushed in the nest. As to the remaining ten eggs, after the hatching date was long overdue, they were opened and the contents were found to be liquid and rotten so they were evidently infertile or the embryo died early.

Actually, in the study, 13.3 per cent of the total complement of eggs did not hatch. However, discounting the 19 that disappeared and the 10 accidentally broken, only 10 eggs out of the 293 or 3.4 per cent failed to hatch because of what might be termed normal causes. In other words about 10 per cent of the total loss was probably abnormal. On this basis the hatching success would have been about 96.6 per cent. This figure is probably high, however, for had there been no disturbance of the colony a few of the 29 lost or broken eggs perhaps would have failed to develop.

EARLY GROWTH OF THE YOUNG

Our study of the development of the young was less successful than that on the eggs primarily because the young were inclined to leave their nests readily and by the time they weighed 500 grams they could scarcely be caught unless chased for many yards. We were particularly reluctant to disturb the colony for fear of increasing the incidence of juvenal mortality through attacks on the young by non-parental adults. We did nevertheless weigh a sample of 128 birds in the early developmental stages.

The average weight for newly hatched young was 50 grams, with extremes of 40 and 60 grams. Newly hatched chicks measured from 5 to 5¾ inches long. The chick that weighed 40 grams was 5¾ inches long while others weighing 50 grams were but 5½ inches long. Differences in weight of 15 to 20 grams were recorded for birds the same length. The weight of the young increased steadily, but the most rapid rise occurred after they weighed 300 to 350 grams. The average gain in weight was 22.5 grams per day. By the time the chicks had attained a length of 12 inches they weighed 500 grams or over and were about 21 days old. Our data do not go beyond this point.

TEMPERATURE REGULATION IN YOUNG

The birds whose temperatures were taken ranged from individuals removed from pipped eggs and those just hatched to young that were almost completely feathered. Readings of both air and cloacal temperatures were taken but no evaluation was made of the microclimate of the ground cover. Following Bartholomew and Dawson (1952), a linear measurement was employed as an indication of relative age. This was the length of the bird from bill tip to the end of the pygostyle as the bird lay in a prone, extended position. There is no perfect correlation between total length and age because of such variable factors as the amount of food and state of health of the young. However, the following is an approximate concordance based on some studies on another sample of young measured at frequent intervals from the time they emerged from the egg until they reached 12 inches in total length. Young in the size category of from 5–5⅞ inches ranged in age from just hatched to one day old, 6–6⅞ inches from 1 to 4½ days, 7–7⅞ inches from 3½ to 7 days, 8–8⅞ inches from 5½ to 9½ days, 9–9⅞ inches from 9½ to 12½ days, 10–10⅞ inches from 13 to 18½ days, 11–12 inches from 15 to 21½ days old.

Some of our temperatures were obtained in 1954. Readings were made on four different occasions when there were considerable differences from time to time in air temperatures. On these occasions the body temperature of the young greatly exceeded the air temperature. While the air temperatures ranged through 25°C. (from 8° to 33°C.) the body temperatures of even the smallest birds varied only a little over 7°C. The data

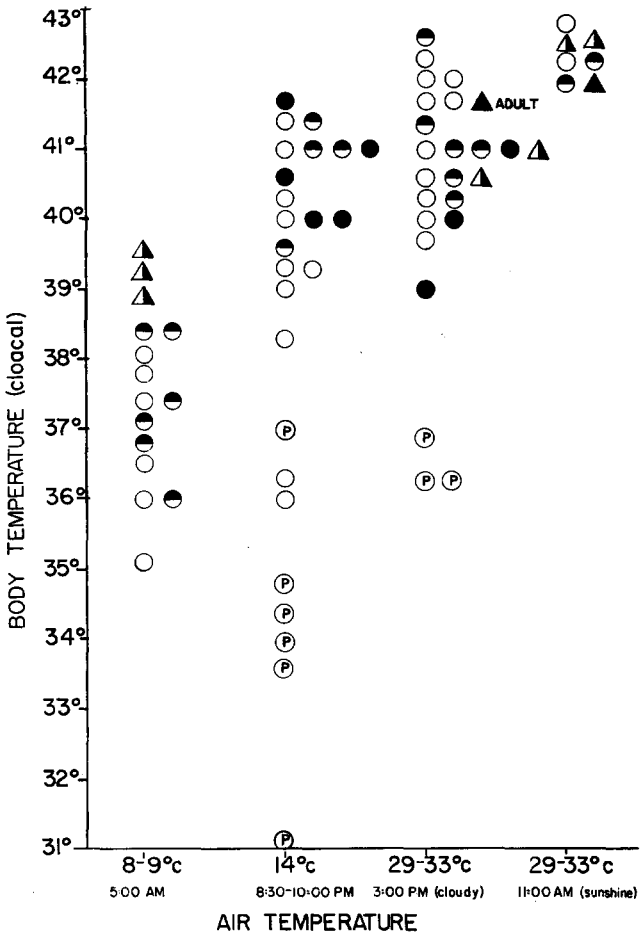

Fig. 1. Cloacal temperatures of nestling California Gulls plotted against air temperature; all in degrees centigrade. Symbols refer to age of birds as represented by body length in inches from tip of bill to end of pygostyle, as follows: circles with central P, birds removed from pipped shells; clear circles, 5 to 6⅞ inches; half-black circles, 7 to 8⅞ inches; black circles, 9 to 10⅞ inches; half-black triangles, 11 to 12⅞ inches; black triangles, over 13 inches, one of which was an adult.

for these samples suggest that up to an air temperature of 14°C. young gulls one or two days old are not able fully to regulate their body temperature. At environmental temperatures from 29° to 33°C. the temperatures of all sizes of young measured are more nearly the same. In other words at temperatures between 29° and 33°C. there was little difference in the body temperatures of newly hatched young and those of larger size. Hence somewhere between these temperatures the young show the ability to maintain their body temperatures when not brooded by the adults.

Realizing the inadequacy of these data special effort was made to gather data for a large sample of young on a relatively cold and constant day. The opportunity was presented on June 3, 1955, when the air temperature varied only from 10° to 11°C. over

a two-hour period, commencing at 9:30 a.m., which length of time it took to gather the data. The results for 1955 are presented in table 4 and corroborate the findings of the previous year. On this cold, misty day the young for the most part had taken shelter in the vegetation and were relatively inactive. Most, especially those of smaller sizes, were picked up without having to be chased. The amount of struggle put up varied with

Table 4

Cloacal Temperature Data for 118 Young California Gulls at Environmental Temperatures of 10° to 11°C.

Size-age group (Total length in inches)	Number of specimens	Temperature extremes	Range of variation
Pipped egg	8	17.5–28.4	10.9
5–5⅞	18	21.2–38.0	16.8
6–6⅞	32	26.6–39.0	12.4
7–7⅞	23	30.0–39.2	9.2
8–8⅞	17	26.8–39.2	12.4
9–9⅞	8	37.2–39.8	2.6
10–10⅞	4	38.6–40.0	1.4
11–12	16	39.4–41.0	1.6
Adult	1	40.0	.....

the individual, some being docile while others fought vigorously. Thus there were many variables. Of the hatched birds, the four smallest categories showed a wide range of cloacal temperatures, suggesting that at these developmental stages the temperature regulatory mechanism is poorly developed, especially in those smaller than 6 inches in length. In the 6–6⅞-inch group the temperatures are bunched near the upper limits. Our sample for the 9 to 9⅞-inch category was small but the individuals fall close together, suggesting that this is about the age of stabilization of the temperature regulatory mechanism. The last size-age category, from 11 to 12 inches in length, had the highest temperatures of all, ranging from 39.4° to 41°C. These are probably close to the temperature of the adults. We were able to get only one adult cloacal temperature of an injured bird; it was 40°C.

The results for the California Gull are similar to those obtained by Bartholomew and Dawson (1952) for the Western Gull (*Larus occidentalis*). They conclude that shortly after hatching the capacity to regulate temperature is sufficiently well developed that in air temperatures between 19° and 28°C. there is little difference in body temperature between newly hatched and fully feathered individuals whereas between 14° and 18°C. the small birds, despite huddling, have more labile body temperatures than do the larger birds.

Bartholomew and Dawson also suggested that Western Gulls have some ability to regulate body temperature before hatching. The basis for this was the data from two specimens removed from pipped eggs that had not been incubated for 45 minutes. The cloacal temperatures of these examples were 32.3° and 33.8°C. when the air temperature was 27°C. Radiant energy had been reduced by a low overcast and shelter from tussocks of grass. With respect to this situation in the California Gull, on the day when the air temperature was 10–11°C. we measured the cloacal temperatures of eight young removed from pipped eggs at the end of the two-hour period of taking temperatures of various sizes of young. The eggs had not been incubated for at least two hours. The cloacal temperatures of these young ranged from 17.5° to 28.4°C. While considerable individual variation was shown, all were substantially higher than the environmental

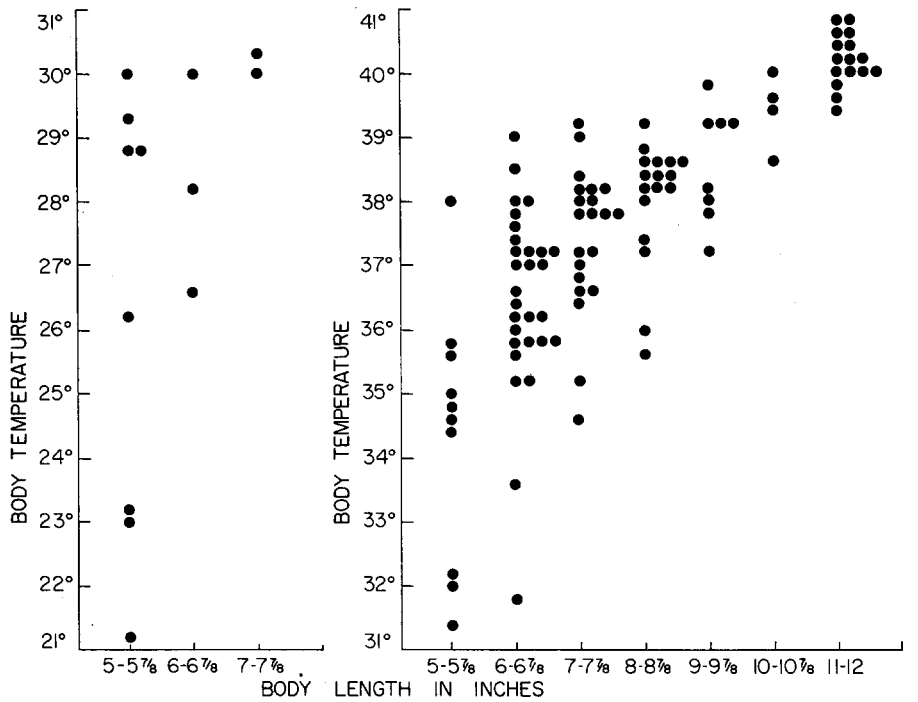

Fig. 2. Cloacal temperatures of nestling California Gulls in degrees centigrade taken when the air temperature ranged from 10° to 11°; age categories expressed in inches of total body length.

temperature. Three recorded as 17.5°, 19°, and 21°C. had temperatures lower than the lowest temperature of newly hatched young in the 5 to 5⅞-inch category. The other six ranged from 22.8° to 28.4°C., which places them in the lower limits of the widespread temperature range of the 5–5⅞-inch groups. The tendency to rapid heat loss in these unhatched birds when exposed is shown by successive readings for two individuals. One dropped from 21° to 19.2°C. in three minutes, the other from 28.4° to 27°C. in one minute. In addition to the relatively large surface area, they were moist and so did not have the dry, fluffy, downy feather covering that a normally hatching gull would have within an hour or so after emerging.

Despite the indication that a heat regulatory mechanism is present at an early stage, there is in young California Gulls heat loss or gain depending on environmental temperatures. If exposed to the direct rays of the sun for a few minutes the body temperature rises. In one experiment in 1954 a chick was exposed to the sun for 20 minutes and its temperature rose 2°C. Probably some young die as a result of this type of overexposure such as occurs when parents are careless in shading them or a disturbance causes the adults to leave their nests. During cold periods when young gulls are unable to supplement their metabolic heat through absorption of radiant energy, their body temperatures drop if there is prolonged exposure. For instance, the temperature of a day-old chick five inches long was taken at 5:00 a.m. when the air temperature was 8°C. After 40 minutes exposure its temperature was again taken. Whereas the air temperature had risen 1°C. that of the gull had dropped from 36° to 31.5°C. As a further indication of a gradually increasing temperature-regulating mechanism, other young a

few days older showed no such loss of body heat after the same length of exposure. In young gulls weighing 350 grams and having a length of 10½ inches, a temperature rise of about 3°C. was noted from night to day. In connection with the influence of the environmental temperature on the gulls' temperature regulating mechanism, mention should be made of two features of behavior. At night the young huddle together presumably in an attempt to conserve heat. During the heat of the day they seek shade in the weeds.

To summarize, the indications are that in the California Gull, a precocial bird, there is some ability on the part of the young as early as the pipped-egg stage to regulate body temperature, but the efficiency of the temperature regulating mechanism increases as they grow older. This may be correlated with the development of the juvenal plumage. A labile condition persists until they reach about 9 inches in total body length. After this the temperature range narrows down and it is probable that by the time the young gull is 12 inches long the cloacal temperature is the same as that of the adult.

JUVENAL MORTALITY

From the 254 eggs that hatched only 177 young finally fledged. The loss of 77 or 30.3 per cent of the young is accounted for as follows. Twenty-one were picked to death by adult gulls. At no time during the course of the study did we witness an egg being broken open or young being molested by adults, but we have observed both acts committed upon other occasions in other colonies. We deduced this to have been the cause of the death of this contingent of young on the basis of the bloody, injured heads and backs. It is difficult to say how much this mortality factor was accentuated by our disturbance of the colony. However, when we were stationed in a blind and the colony was undisturbed, we noted a tendency for young a few days old to leave their nest sites and seek shade in nearby vegetation. At the time of these movements the young were vulnerable to attack by adults other than their parents. Pettingill (1939:423) found this cause of mortality to be important for Arctic Terns (*Sterna paradisaea*) and notes that this form of infanticide is commonly observed in ground-nesting sea-bird colonies.

For the other 56 young found dead there was no obvious cause of death. They were found as a rule in or near the nests. Probably the mortality causes were varied and involved such factors as exposure to rain and cold or extreme heat, disease, and possibly desertion or even starvation. Probably most of this mortality was natural, although conceivably our presence may have been a contributing factor in some instances.

TOTAL MORTALITY AND NESTING SUCCESS

The total mortality from loss of both eggs and young up to the time the young learned to fly and left the island was 116 or 39.5 per cent of the potential number of new gulls (293). Thus the reproductive success was 60.5 per cent.

What percentage of those young gulls that fledged would successfully pass through the juvenal stage and succeeding years until old enough to reproduce is, of course, not known, but the mortality probably continues to be high. Woodbury and Knight (1951: 72) analyzed the data pertaining to returns for bands taken from dead juvenal gulls and showed that the peak of mortality for the California Gulls after the exodus from the nesting areas was in late summer and early fall. A secondary peak extending from November to January also shows on their graph. We have had no returns from the 177 banded gulls that survived the island-rearing period.

Taking into consideration the actual losses in both eggs and young, the following data bear on the success of individual nests. Of the 93 nests that contained 3 eggs at the beginning of the incubation period, only 65 or 69.8 per cent had all eggs hatch. Of

these nests that had 100 per cent hatching success, 22 nests fledged 3 chicks, 29 others fledged 2 young each, 11 fledged one young each and 3 nests were in the end entirely unsuccessful in that all 3 chicks died. Twenty-three nests of the 93 that originally contained 3 eggs hatched 2 eggs. Of these, 12 resulted in 2 fledglings, 9 fledged only one chick each and 2 nests had losses of both their chicks. No instances were observed where only one of the original complement of three eggs hatched, but in five nests not even one of the eggs hatched. Thus from these 93 nests with a full complement of 3 eggs each, 168 fledged chicks resulted. This is a 60.2 per cent reproductive success.

As to the 7 nests with a full complement of 2 eggs each, 3 hatched both eggs and all the chicks lived. Two hatched both eggs but in each case only one chick lived. One hatched only one egg and this resulted in a fledgling. In the last nest of the two-egg category only one egg hatched and the young died. Thus from the 7 two-egg nests, 9 chicks fledged representing a 64.2 per cent reproductive success. Thus a slightly better percentage of reproductive success came from the nests with two eggs. The latter sample was, however, small, and the difference is not significant.

SUMMARY

In the spring of 1954 a study was made of certain aspects of the breeding biology of the California Gull (*Larus californicus*) in a sample of 100 nests at the Farmington Bay Refuge on the east side of Great Salt Lake, Utah. The egg laying commenced about April 5 and was finished on April 23 for the sample, with the peak of egg laying occurring on April 13 when an increase of 52 eggs was noted in a 24-hour period. However, deposition of eggs continued on the island, in other nests which were not part of the sample, until May 20. Ninety-three of the 100 nests finally came to contain 3 eggs each and 7 two eggs each for a total of 293 eggs.

Evidence is presented to show that the species is a determinate egg layer.

The interval between the laying of the first and second eggs varied among nests from 1 to 4 days but in the majority of cases it was 2 days. Likewise the interval between the second and third eggs was in most instances two days.

The average measurements for the first eggs of the sets were 66.5×46.7 mm., for the second egg 66.7×46.7 and for the third egg 65.9×45.5. Sixty eggs had an average weight of 72.7 grams. The first-laid eggs average 73.1 grams, the second eggs, 73.6, and the third eggs, 70.6.

The average incubation time for the first egg was 26.7 days, for the second, 25, and for the third, 23.6. In the majority of nests it was judged that incubation began after the second egg was laid. Hatching began on May 4. The peak occurred on May 12, and all in the sample were hatched by May 19. The eggs that hatched numbered 254 or 86.7 per cent.

The average weight for newly hatched young was 50 grams and such young measured about 5½ inches in length. The average gain in weight was 22.5 grams per day. By the time the chicks had attained a length of 12 inches they weighed 500 grams or more and were about 20 days old.

There is evidence that young one or two days old have some ability to regulate body temperatures; thereafter the efficiency of the temperature regulatory mechanism increases. A labile condition persists until the young reach about 9 inches in total body length; by the time the young gulls are 12 inches long the cloacal temperatures are fairly stable.

There was a loss of 77 or 30.3 per cent of the young. The total mortality among both eggs and young was 116 or 39.5 per cent. Reproduction success was thus 60.5 per cent.

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