

A PROVISIONAL EXPLANATION OF THE  
REPRODUCTIVE FAILURE OF TUFTED PUFFINS LUNDA CIRRHATA

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Ref. No.:

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ON TRIANGLE ISLAND, BRITISH COLUMBIA  
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Tufted Puffins Lunda cirrhata nesting on Triangle Island, British Columbia ( $50^{\circ} 52' N$ ,  $120^{\circ} 05' W$ ), produced 0.46 chicks per breeding pair in 1975, but in 1976 experienced close to a total breeding failure (Vermeer 1978). Most nesting Tufted Puffins deserted their burrows during incubation in 1976. It was thought that desertion may have been a response to actual food shortage, or difficulty in obtaining prey, as a consequence of the storms and excessive rainfall prevailing along the British Columbia coast during the summer of 1976 (Vermeer 1978). In 1977, the reproduction of Tufted Puffins on Triangle Island was again investigated, from 29 June to 11 September.

A general description of the climate, flora and fauna of Triangle Island has been given by Carl, Guiget and Hardy (1951), and its bird fauna has been described in detail by Vermeer, Summers and Bingham (1976).

Nest burrows were investigated on the gentle sloping perimeter, just above cliff faces on the southwestern peninsula of the island. Occupied burrows were checked weekly during incubation. Weights of chicks were recorded daily after hatching. Details of feeding visits by adult Tufted Puffins to their young were noted, and samples of the food brought by adults were collected, identified and measured.

Reproductive success and growth

The percentage hatching success in 1977 was very much higher than in 1976, but in both years only one chick fledged in the burrows investigated

(Table 1). In 1977 the losses commenced, involving desertion and egg disappearance, during the peak of hatching in the second half of July and continued, involving chick mortality, until the end of the rearing period in September (Table 2). The average hatching date in 1977, 25 July was later than that of 1975, 14 July (Figure 1). Obviously, hatching chronology could not be ascertained in 1976 because most eggs were deserted during incubation. The growth curve (Figure 2) has been based on those chicks which showed weight increases up to their asymptote. The curve may therefore represent growth of chicks at levels of nutrition which may have been very low. Examples of progressive individual weight changes of four chicks until death and one up to fledging are shown in Figure 3. Parents were observed to bring food to 16 of 21 chicks from 8 to 24 days after their weights commenced to decline. This suggests that most parents continued to feed their chicks, albeit inadequately, and did not desert completely.

#### Food and feeding activity

In the samples of food brought to the chicks sandlance was predominant, followed by rockfish and sauries (Table 3). The average wet weight of 77 sandlance was 2.5g, that of three sauries 25.7g, but three sauries made up a quarter of the total weight of prey (306g) in 22 complete food loads (Table 3). The average weight of food loads and the average number of sandlance per load decreased from the beginning of August to September (Table 4), suggesting that the availability of this food item decreased as the season progressed. Many of the sandlance delivered to the chicks were still alive, indicating that they were caught in the vicinity of Triangle Island. Tufted Puffins were frequently observed feeding near the

island at the time the chicks were raised. Feeding visits of Tufted Puffins to their young were observed on 6 days. Adults brought food to the chicks chiefly in the morning (Figure 4). Observations on marked burrows containing chicks indicated that the number of feeding visits varied from 0 to 6 per day. Two feeds per day did not appear sufficient to maintain the chicks' growth (Table 5).

#### DISCUSSION

The failure of Tufted Puffins on Triangle Island to rear their young in 1977 cannot be ascribed to bad weather; much sunshine and little rain prevailed during the summer. Breeding attempts also failed elsewhere on Triangle Island outside the study area; hence human disturbance did not appear to be a cause. Murres Uria aalge also experienced low breeding success on Triangle Island in 1977; only ten Murre chicks were observed among approximately 3000 adults. Yet Rhinoceros Auklets Cerorhinca monocerata bred successfully; 68 pairs produced 40 (59%) fledglings. Rhinoceros Auklets hatched on the average 23 days earlier than Tufted Puffins. They fed their chicks mostly sandlance in July and switched to other species, sauries predominantly in August (Table 6). The average weight per food load brought by the Rhinoceros Auklets to their chicks increased significantly ( $P < 0.01$ ) from 25.8g in July to 37.3g during fledging in the second half of August (Table 6). It is notable that in the second half of August the mean food load of Rhinoceros Auklets was about three times that of Tufted Puffins. The difference in food loads is even more striking when the birds' body weights are compared: adult Rhinoceros Auklets av. 521g ( $\underline{n} = 25$ ), and adult Tufted Puffins 745g ( $\underline{n} = 27$ ). Compared to Tufted

Puffin chicks, those of Rhinoceros Auklets in 1977 appeared healthy and well nourished.

Sauries undertake daily vertical migration, rising at sunset to the surface waters where they remain until daybreak (Inoue & Hughes 1971). The Tufted Puffins diurnal feeding habits presumably prevent them from exploiting sauries as a major food resource. Rhinoceros Auklets, by contrast, are both diurnal and crepuscular in their feeding periods. As a further example, Blue Lanternfish Tarletonbeania crenularis, which make vertical migrations similar to that of sauries, were also encountered in Rhinoceros Auklet food samples on Triangle Island during summer 1976. From the comparison of reproductive success and feeding habits of these two alcid species, it appears that the breeding failure of Tufted Puffins in 1977 may have resulted from their inability to switch from a diet of predominantly sandlance to one consisting chiefly of sauries at a time of sandlance shortage.

Average oceanic temperatures were from 1 - 3°C below normal in the northeastern Pacific Ocean during the summer of 1977, and 1°C below normal in the previous two summers. Euphausiid shrimps appeared to be less abundant along the British Columbia coast in 1977 compared to other years; thus, no euphausiid bloom was observed near the Queen Charlotte Islands in 1977 (P.W. Martin, biologist and fisherman, pers. comm.). The low temperatures may also have affected the abundance of sandlance. At Langara Island, Queen Charlotte Islands (54° 13' N, 133° 0' W), Ancient Murrelets Synthliboramphus antiquus, adults which feed mainly on euphausiid shrimp and juveniles on sandlance (Sealy, 1972) have declined from 90,000 pairs (S.G. Sealy pers. comm.) in 1970-1971 to 40,000 pairs (R.W. Campbell,

pers. comm.) in 1977. Both the murrelet decline and puffin reproductive failures may therefore relate to oceanic conditions affecting their food supplies.

#### ACKNOWLEDGEMENTS

The photograph, depicting the Tufted Puffin on Triangle Island was photographed by R. R. Billings and prepared by M. J. Lemon.

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FIGURE 1: Hatching dates (grouped by weeks) of Tufted Puffin chicks at Triangle Island in 1975 and 1977. Dates in 1975 were derived from fledging dates.

FIGURE 2: Mean weights of Tufted Puffin chicks to maximum weight, Triangle Island, 1977. Rectangles show 95% confidence limits, and vertical lines represent the range.

FIGURE 3: Weight changes among five selected Tufted Puffin chicks, Triangle Island, 1977.

FIGURE 4: Number of food loads delivered by Tufted Puffins to their chicks within each half hour throughout the day (0600 to 1930 hrs. P.S.T.). Data cumulative for 24, 26, 28, 30 August and 1, 8 September, Triangle Island, 1977.



TABLE 1

Reproductive success of Tufted Puffins, Triangle Island, in 1975 and 1977

Year	Hatching success		No. chicks		Fledging success	
	No. in sample	%	fledged	% per chick hatched	% per chick hatched	% per egg laid
1975	77	62	80.5	35	56.5	45.5 <sup>1</sup>
1976	70	3	4.3	1	33.3	1.4
1977	111	59	53.2	1	1.9	0.9

Footnote 1: Erroneously shown as 0.66 young per breeding pair by Vermeer (1978).

TABLE 2

Weekly egg and chick losses of Tufted Puffins on Triangle Island, 1977

Week	Number of eggs missing or deserted	Number of chicks died	Total mortality		
			No.	Weekly %	Cumulative %
1- 7 July	2		2	1.8	1.8
8-14 July	3		3	2.7	4.5
15-21 July	11		11	10.0	14.5
22-28 July	17	5	22	20.0	34.5
29 July- 4 August	15	12	27	24.6	59.1
5-11 August	4	8	12	10.9	70.0
12-18 August		8	8	7.3	77.3
19-25 August		11	11	10.0	87.3
26 August- 1 Sept.		6	6	5.5	92.8
2- 8 Sept.		4	4	3.6	96.4
9-15 Sept.		4	4	3.6	100.0
Totals	52	58	110		

TABLE 3

Composition of prey brought by 31 Tufted Puffins to their chicks  
at Triangle Island, 4 August to 5 September, 1977.

Prey Species	% frequency of prey species per load	Average no. of fish per complete load	Wet weight of prey in 22 complete loads	
	( <u>n</u> =31)	( <u>n</u> =22)	(g)	(%)
Sandlance, <u>Ammodytes hexapterus</u>	68	3.67	185	65
Rockfish, <u>Sebastes sp</u>	23	0.43	22	7
Pacific Saurie, <u>Cololabis saira</u>	10	0.14	77	25
Ratfish, <u>Hydrolagus colliei</u>	3	0.05	8	3
Squid, <u>Gonatus anonychus</u>	7*	0.10	14	5

\* Distribution has been extended north to Triangle Island by this observation.

TABLE 4

Comparison of food loads of Tufted Puffins, Triangle Island, 1977.

Time of food load brought	All loads		Loads including sandlance		
	<u>n</u>	Average wet weight per load (g)	<u>n</u>	Average wet weight per load (g)	Average no. of sandlance per load
4- 5 August	7	18.7	4	21.7	7.8
23-31 August	9	13.0	6	10.0	4.3
2- 5 September	6	9.7	5	7.6	4.0

TABLE 5

Feeding visits of Tufted Puffins related to weight change  
of their chicks, 21 August - 10 September, 1977

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No. feeding visits per day	No. chicks	Mean daily weight change of chicks $\pm$ s.d. (g)
0	15	-18.5 $\pm$ 10.4
1	3	-17.0 $\pm$ 17.6
2	5	-15.6 $\pm$ 16.5
3	4	+21.3 $\pm$ 5.0
4	2	+17.0
5	0	-
6	1	+65.0

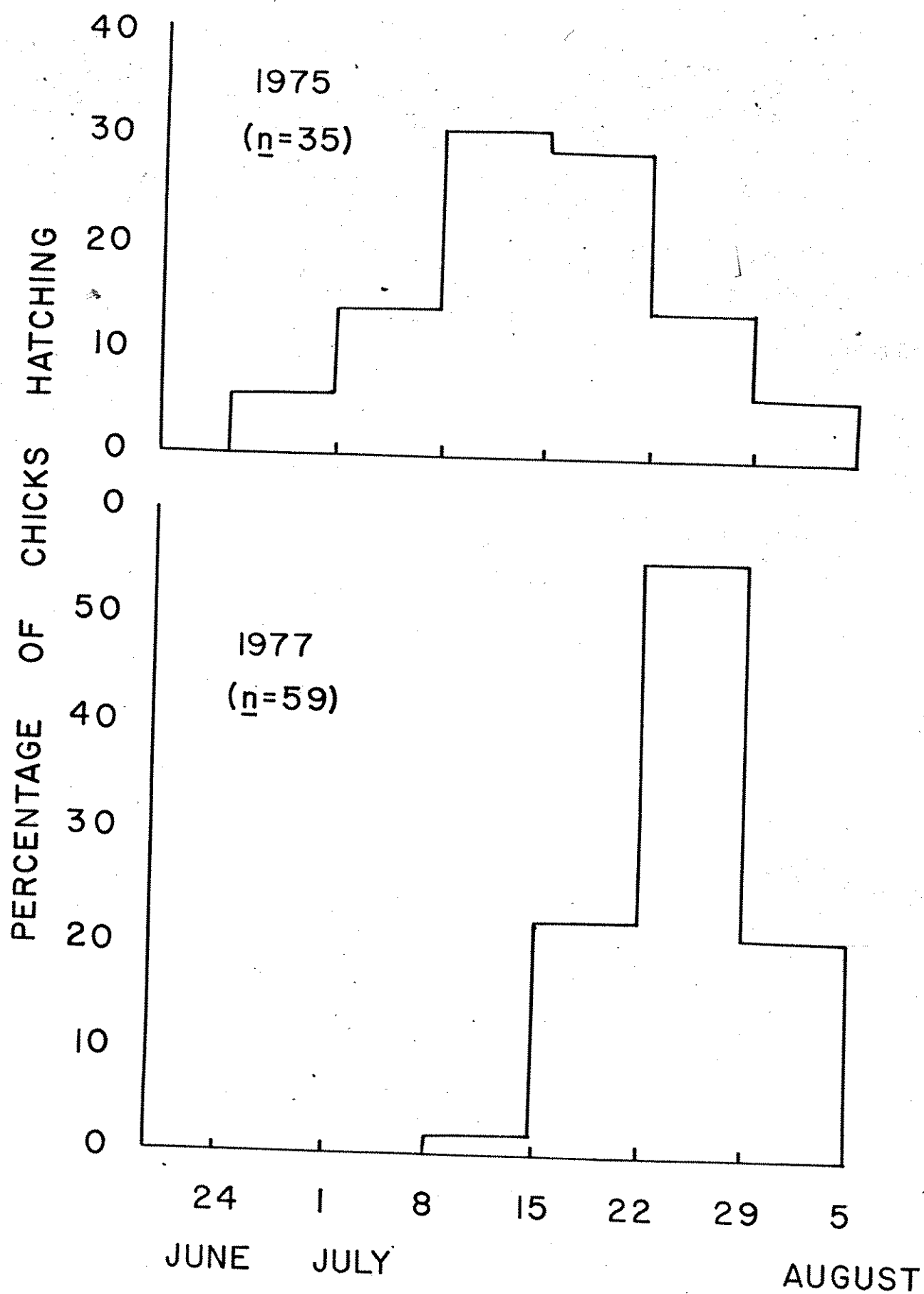
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TABLE 6

Frequency of prey in food loads and wet weight of prey brought  
by Rhinoceros Auklets to their chicks at Triangle Island, 1977

Species	9 - 21 July		11 - 31 August	
	% frequency of prey per load	% weight of prey per load	% frequency	% weight
Sandlance	100	96.4	36.7	17.5
Rockfish	35.5	3.6	0	0
Pacific saurie			76.7	70.6
Sablefish			16.7	6.9
Herring			6.7	2.6
Sockeye salmon			3.3	2.4
Total no. food loads and wet weight in grams	31	799 g.	30	1120 g.

FIGURE 1



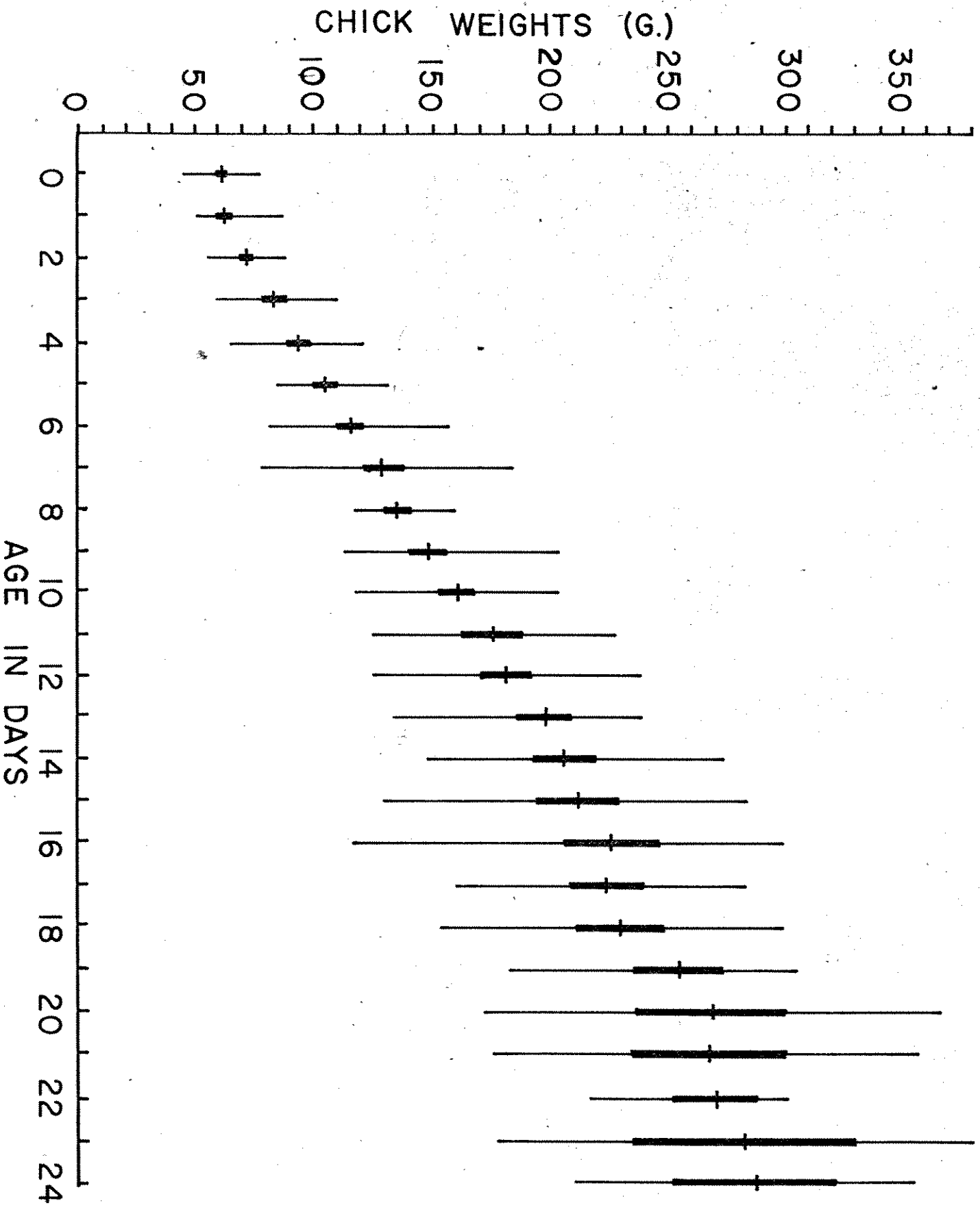
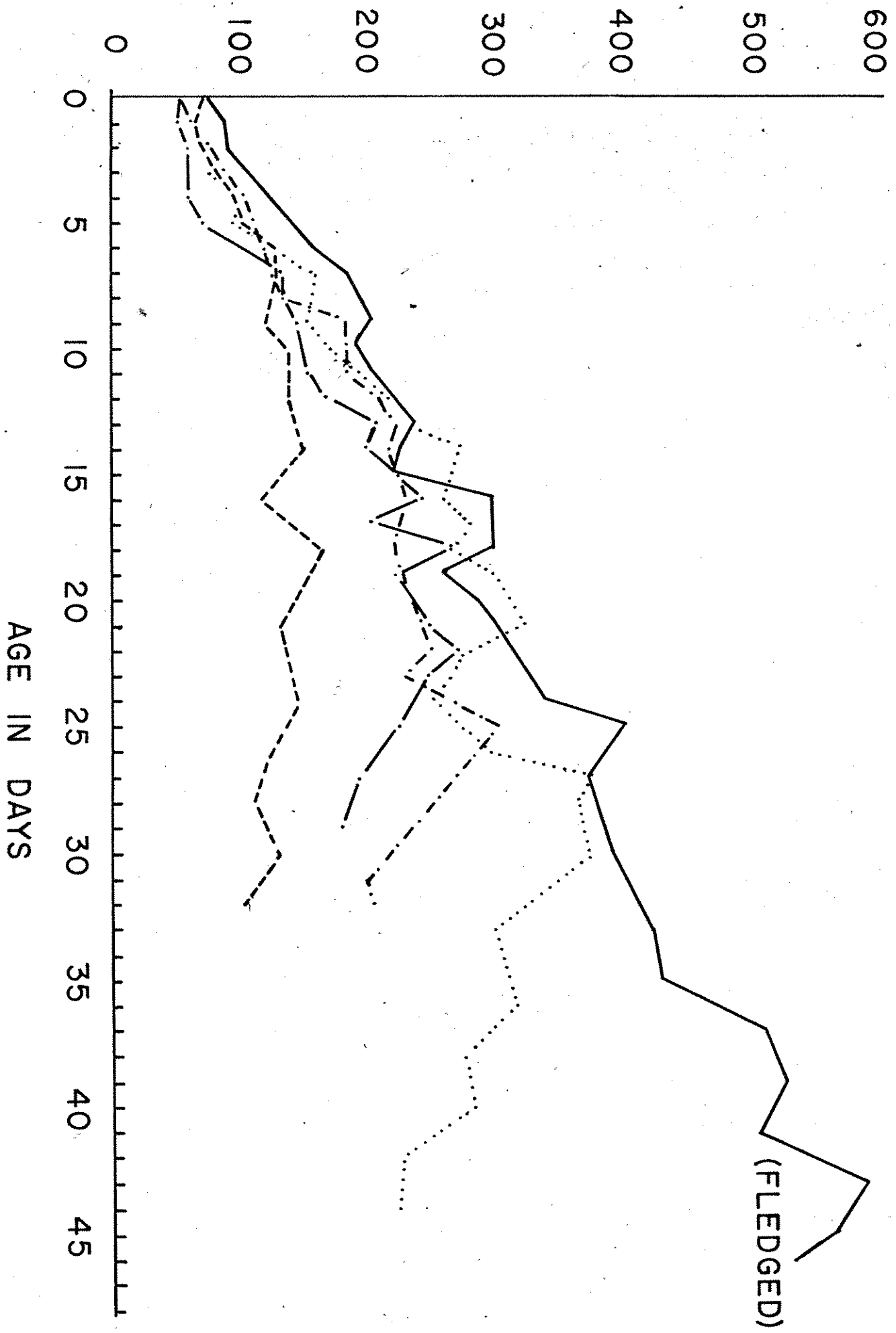


FIGURE 2



CHICK WEIGHT (G.)



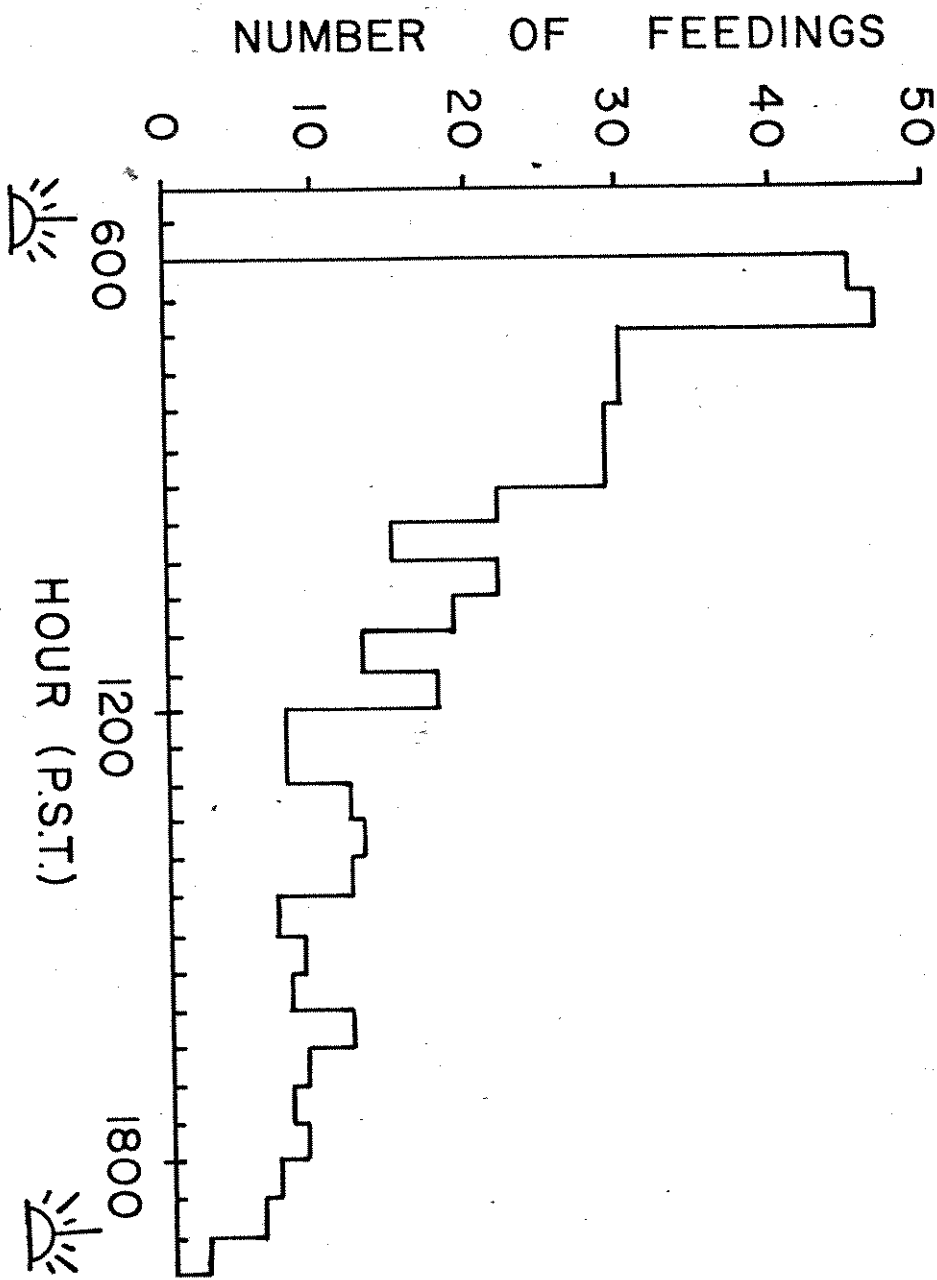


FIGURE 1