NOTEWORTHY BIRD OBSERVATIONS FROM CHIAPAS, MÉXICO

EUGENE HUNN
Department of Anthropology
University of Washington
Seattle, Washington 98105

While engaged in an anthropological investigation of folk-zoology among the Tzeltal-speaking Indians of Tenejapa, Chiapas, México, from April through December 1971, I obtained a number of noteworthy bird records. Those for three shore bird species and the Black-throated Blue Warbler (*Dendroica caerulescens*) are the first published for the state.

Elanus leucurus. White-tailed Kite. These observations are reported to document further the recent expansion of this species in Central America (cf. Eisenmann, Amer. Birds 25:529–536, 1971). White-tailed Kites were observed on three occasions in widely separated areas. One was seen on 20 June at Puerto Arista (sea level); two on 10 November at the Virgin River, near Ocosingo (900 m); and one on 4 December near Villa las Rosas (1350 m), 45 km SE of San Cristóbal. These sightings cover the three major geographical divisions of the state: the Pacific slope, the central depression, and the Gulf slope. This species was first documented for Chiapas by Alvarez del Toro in 1966 (Eisenmann, op. cit.). Additional early sightings not yet published are of single individuals seen on 29 July, 31 July, and 1 August 1965 near Tapachula by D. R. Paulson (pers. comm.).

Charadrius alexandrinus. Snowy Plover. One bird in winter plumage was observed at Puerto Arista on 2 August. The bird was accompanied by Semipalmated Plovers (*Charadrius semipalmatus*), and a close comparison was possible. This locality is at the southeastern extremity of the species' range on the Pacific coast. Blake (Birds of Mexico, Univ. Chicago Press, 1953) states that it winters south only to Nayarit. It has not been recorded in Guatemala (Land, Birds of Guatemala, Livingston Publishing Co., Wynnewood, Penn., 1970).

Charadrius wilsonia. Wilson's Plover. One bird in winter plumage was observed at Puerto Arista on 2 August.

Calidris mauri. Western Sandpiper. Several individuals were seen at Puerto Arista on 2 August and three individuals at Aguacatenango (1700 m), 35 km SE of San Cristóbal, on 22 September. This species and the Wilson's Plover have been recorded on the Pacific coast of Guatemala (Land, op. cit.) and have most likely been overlooked in Chiapas.

Aegolius ridgwayi. Unspotted Saw-whet Owl. Two birds were mist-netted approximately 15 km NE of San Cristóbal in the Municipio de Tenejapa. The first was collected on 3 October at an elevation of 2440 m in the *paraje* of Matzab on the border of a cultivated field and an isolated remnant of cloud forest. The second was collected on 6 December at an elevation of 2200 m at the edge of pine-oak-sweet gum forest in the *rancho* of San Antonio, about 4 km NNW of the site of the first collection. Both have been tentatively identified as adults. This extends the recorded range of this form more than 100 km northwestward and doubles the number of specimens from México (Alvarez del Toro, Las Aves de Chiapas, Gobierno del Estado de Chiapas, 1971). Both specimens have been deposited with the Museum of Vertebrate Zoology, University of California at Berkeley, California, as have duplicate color slides of both specimens taken while they were alive.

Protonotaria citrea. Prothonotary Warbler. One female was observed at length at close range in riverine shrub at San Cristóbal on 9, 13, and 17 September. All three observations are presumably of the same individual. This record, one of the very few for Chiapas (Alvarez del Toro, op. cit.), was made at the unusually high elevation of 2130 m.

Dendroica caerulescens. Black-throated Blue Warbler. One adult male was captured and released on 8 December at an elevation of 2200 m approximately 15 km NE of San Cristóbal in the *rancho* of San Antonio, Municipio de Tenejapa. A duplicate color photograph is deposited with the Museum of Vertebrate Zoology, University of California at Berkeley. All other Mexican (Blake, op. cit.) and Guatemalan (Land, op. cit.) records are from the Caribbean lowlands.

Dendroica chrysoparia. Golden-cheeked Warbler. One adult male in breeding plumage was observed leisurely at close range on 15 September 5 km N of Jitotol (1675 m) on the edge of dry pine-oak woodland. Chiapas is included within the wintering range of this species (Blake, op. cit.). However, the species' small population and precarious status motivates the inclusion of this sighting.

This research was made possible by a Pre-doctoral Combination Fellowship and Research Grant (No. 1 F01 MH49601-01) from the National Institute of Mental Health. I wish to thank Laurence C. Binford and Dennis R. Paulson for helpful comments on the manuscript.

Accepted for publication 20 December 1972.

CLUTCH SIZE, HATCHING SUCCESS, AND EGGSHELL-THINNING IN WESTERN GULLS

GEORGE L. HUNT, JR.
AND
MOLLY W. HUNT
Department of Population and Environmental Biology
University of California, Irvine
Irvine, California 92664

Average clutch size for large *Larus* gulls is close to three eggs, and the production of a clutch of four is uncommon (Keith 1966; Paludan 1951; Vermeer 1963). We report here on a colony of Western Gulls (*Larus occidentalis*) in which many clutches containing four and five eggs were found. It is of particular interest that in these large clutches not only was hatching success low but also eggshell thickness was reduced.

METHODS

The data were collected in May and June 1972, on Santa Barbara Island, Channel Islands, Santa Barbara County, California, during a study of the factors affecting Western Gull chick survival. In each of 63 nests (4% of the colony) in a study area on the west

TABLE 1. Clutch size and hatching success.

	Clutch size					
	1	2	3	4	5	Total
Total no. of nests in main study area	5	12	39	4	3	63
% of clutches in main study area	7.9	19.0	61.9	6.4	4.8	100.0
Total no. of clutches studied	5	12	39	18	6	80
% of eggs hatched (80 clutches)	20.0	45.8	75.2	6.9	0.0	–
% of clutches in which at least one chick hatched (80 clutches)	20.0	58.3	82.1	16.7	0.0	–

side of the island selected prior to the breeding season, clutch size was measured after 2–3 weeks of incubation. Hatching success was determined in these nests and in an additional 17 nests with clutches of four or five in different parts of the colony. Measurements of eggshell thickness were obtained from shells which were recovered after chicks hatched and from eggs which did not hatch. Shell thickness was measured to the nearest hundredth of a millimeter, using dial calipers.

RESULTS

The distribution of clutch sizes and hatching success is presented in table 1. Mean clutch size in the main study area was 2.81. Of these clutches, 11% contained four or five eggs. While we made no attempt to determine the total number of nests with clutches of four or five in the whole colony, we encountered well over the 45 supernormal clutches documented in this study. Thus, while the average clutch size may not have been unusually large, the frequency of supernormal clutches was striking and they were distributed throughout the colony.

Hatching success of eggs was 66.6% within our study area. However, hatching success was much lower for eggs in supernormal clutches (table 1). A count of 50 unhatched clutches on the east side of the island made in mid-June (after 95% of the viable clutches in our main study area had hatched at least one chick) revealed that 42% contained more than three eggs (table 2), as opposed to an overall 11%

TABLE 2. Distribution of clutch sizes among 50 unhatched clutches.

Clutch size	% of sample
5	4
4	38
3	24
2	22
1	12
	100%

TABLE 3. Eggshell thickness vs. hatching success.

	All clutches		Clutch size 1–3	
	None hatched	1 ≤ hatched	None hatched	1 ≤ hatched
No. of eggs	86	41	27	30
Mean shell thickness (mm)	0.31	0.36	0.31	0.37
Range of variation (mm)	0.22–0.43	0.29–0.46	0.22–0.43	0.30–0.46

in our study area prior to hatching. Again, our impression was that throughout the colony hatching success was abnormally low in clutches of four and five eggs.

No embryos were found in eggs from clutches in which no eggs hatched, although due to the advanced state of decay of these eggs, very small embryos might have been overlooked. In clutches in which some of the eggs hatched, 3 of 11 unhatched eggs contained well-developed embryos.

Measurements of eggshell thickness revealed that shells from all clutches in which no eggs hatched were significantly thinner ($Z = 6.620$, $P < 0.01$) than those from clutches in which at least one egg hatched (table 3). However, only one egg out of 127 was actually crushed. The relationship between thinner shells and failure to hatch was also significant ($Z = 3.927$, $P < 0.01$) when only normal clutches of one to three eggs were considered (table 3).

Thinner eggshells were not distributed randomly through clutches of all sizes but were particularly prevalent in the larger clutches (table 4). Differences in shell thickness between clutches of three eggs and those of four and five eggs were statistically significant ($t = 1.8899$, $P < 0.05$, clutch size 3 vs. 5; $Z = 4.568$, $P < 0.01$, clutch size 3 vs. 4).

Maximum variation in shell thickness within a clutch was generally greater in clutches in which one or more eggs hatched than in clutches in which no eggs hatched (table 5). Contrary to what might have been expected, variation in eggshell thickness within clutches of four was similar to that within clutches of three eggs (using only clutches for which shell-thickness data was available for the entire clutch). Although shell-thickness measurements were not obtained for all of the eggs in any of the five-egg clutches, the range of variation found in those clutches in which three or four of the five eggs were measured appears to be about the same as the range obtained from three- and four-egg clutches.

TABLE 4. Eggshell thickness by clutch size.

	Clutch size				
	1	2	3	4	5
No. of eggs	1	14	44	54	16
Average thickness (mm)	0.34	0.35	0.35	0.31	0.32
Standard Deviation ±	–	0.053	0.050	0.025	0.032

TABLE 5. Maximum variation in eggshell thickness within clutches.

Clutch size	2				3				4				5	
	H[a]		NH[b]		H[a]		NH[b]		H[a]		NH[b]		NH[b]	
	mm	%[c]	mm	%[c]	mm	%[c]	mm	%[c]	mm	%[c]	mm	%[c]	mm	%[c]
	0.01	2.9	0.05	14.9	0.03	7.8	0.02	6.7	0.10	27.8	0.02	6.7	0.06	20.5
			0.01	3.1	0.05	12.6	0.02	6.5	0.03	10.0	0.06	20.0	0.06	18.9
			0.05	18.2	0.16	42.9	0.03	10.2			0.01	3.3	0.04	11.7
			0.00	0.0	0.02	5.8	0.13	43.8			0.03	3.3	0.05	17.4
							0.01	3.3			0.05	17.9		
							0.03	9.0			0.05	16.7		
Mean	–	–	0.03	9.1	0.07	17.3	0.04	13.3	0.07	18.9	0.04	11.3	0.05	17.1

[a] 1 ≤ egg(s) hatched.
[b] No eggs hatched.
[c] Calculated by dividing the difference between thickest and thinnest shell in each clutch by the average shell thickness in that clutch.

DISCUSSION

Since our measurements of clutch size were made near the end of the incubation period, it is likely that clutches on the average were larger at completion than when we recorded them (Keith 1966). Our observation that 11% of the clutches consisted of more than three eggs agrees with the data of Schreiber (1970), who found in 1968 that 11.3% of 150 Western Gull clutches on San Nicolas Island (48 km SW of Santa Barbara Island) were supernormal at the time of laying. Although Schreiber suggested, on the grounds of differences in coloration, that the larger clutches which he found may have been laid by more than one female using the same nest, we found no evidence to support this hypothesis.

Clutches of more than three eggs are apparently exceptional in other colonies of Western Gulls. Harper (1971) found only one four-egg clutch out of 50 studied in 1965 and 1966 on Bird Rock, 51 km E of Santa Barbara Island, off the northeast coast of Santa Catalina Island. On the Farallon Islands, W of San Francisco, only two four-egg clutches have been noted out of many thousands in 5 years of study (John Smail, pers. comm.). The data of Paludan (1951) on *L. fuscus*, of Vermeer (1963) on *L. glaucescens*, and a review of clutch size in *L. argentatus* (Keith 1966) all confirm that clutches of four eggs are extremely rare in these closely related large gulls.

Failure of eggs to hatch may be caused by lack of sufficient heat during incubation. Schreiber (1970), who also found very low hatching success in supernormal clutches of Western Gulls, reasoned that large clutches failed to hatch because the eggs received insufficient warmth from the three brood patches of the gulls. While we also found only three brood patches on each of five gulls captured while incubating clutches of four eggs, we feel that this hypothesis remains to be tested. Furthermore, it provides no explanation for the correlation of hatching failure and eggshell-thinning in clutches of three eggs as well as in clutches of four and five eggs.

At least three factors have been related to eggshell-thinning. Rothstein (1972) has found in Cedar Waxwings (*Bombycilla cedrorum*) that eggshells become progressively thinner as embryonic development proceeds. Since the thinning of eggshells by developing embryos would tend to lessen the differences which we found between eggs from clutches in which at least one egg hatched and clutches in which none hatched, this cause of thinning cannot be the explanation of the differences which we found between eggshell thickness in normal and supernormal clutches. It may, however, be the explanation for the variability in shell thickness found in clutches in which at least one egg hatched.

Secondly, Rothstein (1972) found that mean shell thickness becomes progressively smaller as clutches become larger. That the production of four and five eggs may have taxed the ability of the female gulls to mobilize sufficient calcium cannot be ruled out. However, Western Gulls may well have greater ability to mobilize calcium than the Cedar Waxwings studied by Rothstein, especially in view of the primarily fish diet consumed by Western Gulls on Santa Barbara Island (Hunt and Hunt, unpubl. data). Since there was no decrease in shell thickness between clutch size four and five comparable to that found between clutch size three and four, we doubt that the enlargement of the clutch size was the cause of eggshell-thinning. Furthermore, we did not find an increase in the variability of eggshell thickness in supernormal clutches (table 5) such as Rothstein (1972) found in his Cedar Waxwings.

Thirdly, the thinning of eggshells has been found to be correlated with the presence of DDE residues (Ludwig and Tomoff 1966; Keith 1966; Hickey and Anderson 1968; Anderson et al. 1970; Blus 1970; Blus et al. 1971, 1972). At present, we have no data on the current levels of DDE in the eggs of Western Gulls nesting on Santa Barbara Island. Robert W. Risebrough and Daniel W. Anderson (pers. comm.) have data which show that, prior to 1937, Western Gulls in the Channel Islands had an average shell thickness of 0.413 mm, with a range of 0.38–0.44 mm (based on nine clutches of three eggs each). Thus, our measurements indicate a general thinning of eggshells, which may be the result of DDE contamination. Risebrough (pers. comm.) has informed us that mussels (*Mytilus californianus*) in the intertidal zone of Santa Barbara Island contain higher levels of DDE and PCB than mussels of the Channel Islands to the north. However, the role of pesticides in the eggshell-thinning and the failure to hatch which we found will not be known until pesticide residue analysis is performed on the eggs of the gulls.

It is tempting to infer from our observations that the evolution of clutch size in gulls may be limited by their inability to incubate successfully more than three eggs. However, until the causes of the observed eggshell-thinning and hatching failure are determined, the use of our data in discussions of the adaptive

significance and evolution of clutch and brood size in gulls will be premature.

We would like to thank the following people for their help and support in various aspects of this project: the personnel of the Channel Islands National Monument, the Captain and crew of the Coast Guard Cutter *Walnut*, Mr. and Mrs. John H. Porter, Jr., William Connolly, Mary Zetlmaier Fox, Diane Littler, and Brian Atsatt. Financial support was provided by a Biomedical Sciences Support Grant to the School of Biological Sciences, University of California, Irvine. The manuscript has benefitted from critical reading by Richard E. MacMillen, Robert W. Risebrough, and Ralph W. Schreiber.

LITERATURE CITED

ANDERSON, D. W., J. J. HICKEY, AND J. A. KEITH. 1970. Chlorinated hydrocarbons and eggshell variation in Herring Gulls. Unpublished report to United States Fish and Wildlife Service, 24 July 1970.

BLUS, L. J. 1970. Measurements of Brown Pelican eggshells from Florida and California. BioScience 20:867–869.

BLUS, L. J., C. D. GISH, A. A. BELISLE, AND R. M. PROUTY. 1972. Logarithmic relationship of DDE residues to eggshell thinning. Nature 235:376–377.

BLUS, L. J., R. G. HEATH, C. D. GISH, A. A. BELISLE, AND R. M. PROUTY. 1971. Eggshell thinning in the Brown Pelican: Implication of DDE. BioScience 21:1213–1215.

HARPER, C. A. 1971. Breeding biology of a small colony of Western Gulls (*Larus occidentalis wymani*) in California. Condor 73:337–341.

HICKEY, J. J., AND D. W. ANDERSON. 1968. Chlorinated hydrocarbons and eggshell changes in raptorial and fish-eating birds. Science 162: 271–273.

KEITH, J. A. 1966. Reproduction in a population of Herring Gulls (*Larus argentatus*) contaminated by DDT. J. Appl. Ecol. Suppl. 3:57–70.

LUDWIG, J. P., AND C. S. TOMOFF. 1966. Reproductive success and insecticide residues in Lake Michigan Herring Gulls. The Jack-Pine Warbler 44:77–84.

PALUDAN, K. 1951. Contributions to the breeding biology of *Larus argentatus* and *Larus fuscus*. Vidensk. Medd. Dansk Naturh. Foren. 114:1–128.

ROTHSTEIN, S. I. 1972. Eggshell thickness and its variation in the Cedar Waxwing. Wilson Bull. 84:469–474.

SCHREIBER, R. W. 1970. Breeding biology of Western Gulls (*Larus occidentalis*) on San Nicolas Island, California, 1968. Condor 72:133–140.

VERMEER, K. 1963. The breeding ecology of the Glaucous-winged Gull (*Larus glaucescens*) on Mandarte Island, B.C. Occ. Papers Brit. Columbia Prov. Mus. 13:1–104.

Accepted for publication 16 March 1973.