The Diet of Mediterranean Gull (*Larus melanocephalus*) Chicks at Fledging

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GOUTNER, V. (1994): The diet of Mediterranean Gull (*Larus melanocephalus*) chicks at fledging. J. Orn. 135: 193–201. – The diet of Mediterranean Gull chicks was investigated in a Macedonian wetland using three different sampling methods: stomachs from freshly dead chicks (1988), regurgitations (1987) and carcass stomachs (1986–88). In fresh stomachs, gastropods were the most important animal prey by mass and insects by numbers. In terms of overall volume and biomass, wheat grains were the most important food. In regurgitations and carcass stomachs insects were the most important prey. Comparison of the results from the different methods revealed considerable differences which are attributed to feeding behaviour of the gulls and prey dynamics rather than the methodology used. The importance of prey types is discussed; composition of diet probably differs considerably between geographical areas

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Introduction

Mediterranean Gulls (*Larus melanocephalus*) breed in a limited number of colonies in the Mediterranean and the Black Sea areas (CRAMP & SIMMONS 1983); the largest colony is in the Chernomorski Reserve, Northern Black Sea (VOINSTVENSKI 1988). In the Mediterranean, these colonies occur on its north coast. A recent westwards expansion has occurred, and local populations fluctuate (GOUTNER & ISENMANN 1993). The diet of Mediterranean Gulls has been studied in some areas during the breeding season through a variety of methods. In the Chernomorski area, Black Sea, BORODULINA (in CRAMP & SIMMONS 1983) analysed 30 stomachs and 19 regurgitations. In the same region (Tendra Bay) KISTYAKIVSKI (1957) analysed 53 stomachs and ARDAMATSKAYA et al. (1988) 458 regurgitations. In a Greek colony, ISENMANN (1975) collected and analysed 688 items disgorged by adults and chicks. In the Evros Delta, Greece, GOUTNER (1986) collected regurgitations in 1984 and 1985; and in the Adriatic Sea FASOLA et al. (1989) collected spontaneous chick regurgitations, food samples from chicks fitted with collars and made direct observations from hides of prey regurgitated by adults during the feeding of chicks. In none of the above mentioned studies an evaluation of the sampling method was given.

This study, carried out in the largest Mediterranean colony of Mediterranean Gulls, tries to describe the diet of chicks at fledging using a number of different sampling methods and to compare the results with the studies cited above.

Study area and methods

This study was carried out in the Alyki Kitrous area (40° 22' N, 22° 38' E), a Macedonian wetland at the western end of the Gulf of Thessaloniki, Greece. The area has important ornithological and herpetological value and has been described in detail by STUBBS et al. (1981) and GOUTNER & PAPAKOSTAS (1992). It comprises a shallow lagoon, separated from the sea to the south-east by a sandy heath and to the north-west by industrial salines. In the study years (1986—1988) the Mediterranean Gull colony was situated on islets covered with halophilous vegetation in the southern part of the lagoon.

Material for the food study was collected in 1986, 1987 and 1988 in three different ways. First, stomachs of freshly dead chicks were collected in 1988 during the last third of the fledging period, that is between 25 June and 5 July (GOUTNER 1986). Stomachs were stored in 10 % formalin, and after five days were placed in 70 % alcohol until analysis. Second, regurgitations were collected mainly in 1987 (79 % of the total) between the above mentioned dates and stored in 70 % alcohol. Third, I visited the colony site late in August in all study years and collected stomachs from chicks which had died during the third part of the fledging period estimating their age by their plumage characteristics and bill size (unpubl. data). I had found that in already decomposed chicks stomach formed a hardened and resistant sac where a variety of food items were preserved in good condition. The contents of carcass stomachs were preserved dry in glass tubes.

Each stomach was opened and items were separated into categories, counted and identified. Animal material was weighed after the excess moisture was removed by soft blotting paper and by exposure of material in room temperature. Volume was measured in a graduated volumetric cylinder. I removed the excess preservative from wheat grains by drying this material in an automatic electric dryer at 65 °C for one hour and then exposed it in room temperature until constant mass. In the first 15 samples, mass and volume of wheat grains were very similar ($Z = 1.34$, $P = 0.18$, Sign test), so I thereafter measured wheat mass. Mass and volume of the total number of insects in a stomach were corrected based on the intact individuals found. Regurgitations was removed from alcoholic preservative, dried with blotting paper and exposed at room temperature. Items were then separated, counted, massed and identified. In each carcass stomachs I only recorded the number of items. For wheat grains, I recorded the number of carcass stomachs containing grains.

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Results

Fresh stomachs (Table, Appendix I)

In terms of frequency of occurrence, molluscs dominated in the diet of Mediterranean Gull chicks (frequency of occurence is the proportion of stomachs which contained a particular prey). Although Gastropods were found in 26.1 % of the samples, of all animal material their contribution by mass was the highest. Of bivalves only parts of shells were found in the stomachs. Insects were found in 57.9 % of the stomachs and

Comparison of the main constituents of the diet of Mediterranean Gull chicks in Macedonia investigated by three different sampling methods. Comparison were made by χ^2-Test or Fisher Exact Test were appropriate. df = 1 in all cases. F: frequency; % N: percent numbers.

	Fresh Stomachs (FS)		Carcass Stomachs (CS)				Regurgitations (R)		Comparison of FS-CS (1988) (significance)		Comparison of R-CS (1987) significance	
	F	% N	F		% N		F	% N	F	% N	F	% N
	(1988)		1987	1988	1987	1988	(1987)					
INSECTA	57.9	46.5	78.9	92.9	58.5	94.4	91.3	77.4	0.027	<0.001	n.s	<0.001
Coleoptera	40.9	40.3	63.2	78.6	16.8	71.0	69.6	47.0	0.019	<0.001	n.s	<0.001
Orthoptera	17.0	3.2	36.8	28.6	5.0	5.6	52.2	3.5	n.s	n.s	n.s	n.s
Hymenoptera			10.5	28.6	35.5	17.5	47.8	22.1			0.023	<0.001
MOLLUSCA	68.2	38.3	42.1	50.0	40.2	3.7	34.8	8.9	n.s	<0.001	n.s	<0.001
Bivalvia	53.4	4.9	10.5	42.9	0.7	2.2			n.s	<0.001		
Gastropoda	26.2	33.2	36.8	7.1	39.4	1.5	30.5	8.8	n.s	<0.001	n.s	<0.001
WHEAT	46.6	3.7	15.8	21.4	0.6	1.1	—	—	n.s	—	0.05	—

their numbers and volume were the highest of all animal material. Coleoptera were the most important insects in the diet. Of these, Carabidae dominated by number whereas Melolonthidae did so by mass and volume. Wheat grains were found in 46.6 % of stomachs and in terms of biomass were by far the most important food also making the greatest contribution by volume proportion. Other invertebrate and vertebrate food were of minor importance. From a number of items taken, it is clear that some chicks were fed in part on human refuse, probably from rubbish dumps. 37.5 % of stomachs contained small stones.

Regurgitations (Table, Appendix II)

Insects were the most important items in regurgitations in terms both of frequency and numbers. Coleoptera were the most important insects with Carabidae dominating. Orthoptera biomass was greater of that of Coleoptera despite lower numbers because of a generally larger size of the former. A considerable number of insect families were represented in this type of samples. Although some of them occurred in moderate frequencies, numbers and biomass were low. Fish were found in about one quarter of the samples and despite low numbers, their biomass was second in importance (8.7 %), after insects. Gastropods occurred in low numbers and biomass despite a 30.5 % frequency in the samples, reflecting small-sized individuals. Only in this type of samples did we find Oligochaeta annelids but in a moderate overall frequency and low numbers and biomass. Of other material, part constituted items probably scavenged as refuse. Wheat grains were absent from regurgitations.

Carcass stomachs (Table, Appendix III)

Insects were by far the most frequent and numerous items in this type of sample. There was no consistency in the frequencies of insects in the samples and their numbers differed significantly among years ($\chi^2 = 103.7$, $P < 0.001$). Of insects, Coleoptera occurred more frequently and they were also the most abundant, except in 1987 when Hymen-

optera dominated. Melolonthidae and Carabidae were the most important Coleoptera. Other insects were found in much lower frequencies but Heteroptera were occasionally important (in 1986). There was a consistency in frequencies and/or numerical proportions within some insect taxa such as Melolonthidae, Curculionidae, Orthoptera and Hemiptera, at least two of the three study years. In all years about 50 % of the samples contained molluscs (fragments of bivalve shells and whole gastropods shells). Numbers of molluscs differed significantly among years (χ^2 = 117.95, $P < 0.001$). Other animal food was a minor constituent in this type of samples throughout the study. A considerable proportion of samples contained wheat grains. Certain items suggested that part of the chick food was collected near human settlements.

Evaluation of food sampling methods

To evaluate the food sampling methods used in this study I compared frequencies and numbers of food items a) between fresh stomachs and carcass stomachs in 1988 and b) between carcass stomachs and regurgitations in 1987.

a) Insects in general occurred in significantly higher frequencies in carcass stomachs and also in higher proportions by number (Table). This trend also held for the most important used order of Coleoptera. Their proportions by number were significantly higher in carcass stomachs (χ^2 = 646.8, $P < 0.001$). Orthoptera frequencies and numbers did not differ significantly between the two types of samples. In general, molluscs had similar frequencies but significantly greater numbers in fresh stomachs. Bivalve frequencies did not differ between the two sample types, but numbers were higher in fresh stomachs. Gastropod frequencies did not differ significantly. Frequencies and numbers of other animal food were small for comparisons. Wheat frequencies did not differ significantly between the two types of samples. This analysis revealed considerable differences in the proportions of numbers of the most important food items between different samples. However, frequencies were significantly different only for insects in general and for coleopterans (main insect prey).

b) In regurgitations and carcass stomachs insects dominated among other food items and they occurred at similar frequencies in both, but in significantly different numbers in the former (Table). Coleoptera frequencies did not differ between these sample types, but number proportions did, being significantly higher in carcass stomachs. More coleopteran families and species were represented in regurgitations. Representation of Orthoptera was similar in the two sample types in terms of both frequencies and numbers. Hymenoptera were more frequent in regurgitations but more numerous in carcass stomachs. Gastropod frequencies did not differ significantly but numbers did, being higher in carcass stomachs. This comparison indicated significant differences in the number proportions of the most important food items, whereas frequencies only occasionally differed.

Discussion

The comparisons of sampling methods revealed that the frequency of occurrence of many important food items did not differ between sample types of the same year. However, considerable differences were found in the proportions by number of many

important food items. Additionally, a considerable variation was found in food items taken and in numbers of the same item occurring in different samples in the same season. Such differences may be due to the feeding behaviour of Mediterranean Gulls because of a patchy exploitation of the available foods in a great variety of habitats used by exploiting an area of at least 30 km radius around the colony (ISENMANN 1975, CRAMP & SIMMONS 1983, GOUTNER 1986, pers. obs.)

Inter-annual differences in diet studied with the same sampling method might be attributed to different food availability and to changes in feeding habitats used. Such differences have been detected in other studies on Mediterranean Gulls and Gull-billed Terns (*Gelochelidon nilotica*), carried out in Greece (GOUTNER 1986, 1991). An assessment of the type of sample in the evaluation of the diet of Mediterranean Gulls may be drawn by the presence of great quantities of wheat in stomaches and absence from regurgitations. Both regurgitations and fresh stomachs were collected at approximately the same dates each year and wheat was equally available because agricultutal practices remained the same both years. Additionally, the comparison between carcass stomaches and regurgitations in 1987 shows that the frequency of occurrence of wheat is different in the two sample types (Table). Thus, absence of wheat from regurgitations may be due to the type of these samples and not to the sampling procedure. Finally it is possible that not all individual birds regurgitate to the same degree (DUFFY & JACKSON 1986), so some food types may be underestimated.

Wheat constituted the major component of the diet of chicks found dead with no obvious evidence of injury. This, in combination with the absence of wheat from regurgitations, raises the possibility that these chicks died as a direct result of ingesting wheat which is not a normal component in the diet of gulls.

An important component of chicks' diet were Gastropods constituting a good source of both protein (ARDEMAGNI et al. 1977, GRANDI & PANELLA 1978) and calcium (GRASSÉ 1960). Bivalve shells and *Sepia* cuttlebones probably serve as a calcium supplement to developing chicks. Small stones that were found in many stomachs may help in crushing the hard shelled items.

The diet of Mediterranean Gulls differs considerably among different geographical areas (literature mentioned above). This variability may be due to methodological differences but also differences in the type and extent of the available feeding habitats in each particular area and feeding relationships with the other co-existing seabirds (FASOLA et al. 1989, 1993). Due to lack of coordinated studies on the feeding ecology of Mediterranean Gulls in the Mediterranean and Black Sea regions, there may be factors responsible for the variability in diet which are still unknown.

Zusammenfassung

In einem Feuchtgebiet Mazedoniens wurde die Nahrung junger Schwarzkopfmöwen nach drei verschiedenen Methoden untersucht: Magenanalysen frischtoter Küken (1988), ausgewürgte Nahrungsbestandteile (1987) and Mageninhalte toter Jungvögel (1986—88). In frischen Mageninhalten machten der Masse nach Gastropoden, der Zahl nach Insekten die wichtigsten Nahrungsanteile aus. In allen Proben bildeten in Volumen und Biomasse Weizenkörner die wich-

tigste Nahrung, in ausgewürgten Proben und Mageninhalten toter Vögel Insekten. Der Vergleich der nach unterschiedlichen Methoden gewonnenen Ergebnisse ergab bemerkenswerte Unterschiede der Zahlenververhältnisse, doch nur gelegentliche Unterschiede in den Anteilen der wichtigsten Nahrungsbestandteile. Solche Unterschiede sind hauptsächlich auf das Verhalten der Möwen bei der Nahrunungssuche und auf die Dynamik des Beuteangebots zurückzuführen, weniger auf die Methodik der Probengewinnung. Erhebliche geographische Unterschiede in der Ernährung der Küken scheinen zu bestehen.

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Appendix I

Food items in fresh stomachs of Mediterranean Gull chicks, 1988 (N = 88)

Type of food	Frequency	% Number (g)	% Mass	% Volume (cm^3)
Insecta	57.9	46.5	12.7	20.7
Coleoptera	40.9	40.3	10.2	17.8
Carabidae	19.3	26.8	3.3	6.4
Ophonus	6.8	19.9	1.2	3.6
Harpalus	1.1	1.0	0.1	0.1
Melolonthidae	17.0	10.3	6.2	10.7
Anomala	7.9	7.2	2.5	4.4
Polyphylla	5.7	3.1	2.8	4.9
Orthoptera	17.0	3.2	2.3	2.4
Gryllotalpa gryllotalpa	3.4	1.0	1.0	1.0
Heteroptera	6.8	1.5	0.3	0.5
Scutelleridae: *Eurygaster maura*	2.3	1.0	0.2	0.3
Mollusca	68.2	38.3	16.6	14.7
Gastropoda: Helicellinae	26.1	33.2	16.1	14.3
Bivalvia	53.4	4.9	—	—
Crustacea	9.1	8.2	9.3	7.9
Decapoda: *Upogebia pusilla*	4.5	3.7	9.3	7.9
Amphipoda: *Talorchestia*	1.1	4.1	0.1	0.1
Plant material	60.1	5.3	45.8	42.5
Wheat	46.6	3.7	44.3	40.9
Digested material	28.4	—	6.9	6.9
Totals	88	1096	496.9	537.7

Items below 1% by number: Coleoptera: *Melolontha*, *Pentodon idiota*, *Pentodon*, *Phosphuga atrata*, Tenebrionidae, Curculionidae; Orthoptera: *Tettigonia caudata*, *Tettigonia*, *Decticus albifrons*, *Calliptamus*; Heteroptera: *Acrosternum*; Diptera: *Helophilus*, Asilidae, Lepidoptera (larvae); Arachnida; Bivalvia: *Tellina pulchella*, *Tellina*, *Donacilla cornea*, *Spisula subtruncata*, *Spisula*, *Ctena decussata*; Cephalopoda: *Sepia*; Isopoda: *Cymothoa*; Osteichthyes; Mammalia: *Microtus*; Annelida; Reptilia; Plant material: Olives, walnuts, beans, peanuts, watermelon, other seeds, wood, *Halocnemum strobilaceum*; Other material: meat, bone, chewing gum, plastic, stones.

Appendix II

Food items in regurgitations of Mediterranean Gull chicks, 1987 (N = 23)

Type of food	Frequency	% Number	% Mass (g)
Insecta	91.3	77.4	46.7
Coleoptera	69.6	47.0	16.6
Carabidae	52.2	25.5	9.8
Zabrus	4.3	6.7	6.1
Melolonthidae	17.4	2.1	2.8
Amara	26.1	12.7	1.3
Anomala	8.7	1.6	2.4
Curculionidae	30.4	12.0	0.9
Chrysomelidae	13.0	11.1	0.5
Gonioctena	4.3	2.4	0.5
Elateridae	17.4	1.3	0.1
Elateridae larvae	13.0	1.2	0.1
Hymenoptera	47.8	22.1	0.9
Formicidae	43.5	21.7	0.8
Formica rufa	4.3	2.7	0.2
Formica fusca	8.7	2.5	0.2
Myrmica	17.4	4.5	0.2
Orthoptera	52.2	3.5	29.0
Gryllotalpa gryllotalpa	39.1	2.4	21.8
Dermaptera	4.3	1.2	0.1
Mollusca	34.8	8.9	2.9
Gastropoda	30.4	8.8	2.9
Helicellinae	26.1	8.7	2.9
Crustacea	34.8	6.6	3.0
Isopoda	30.5	6.1	1.2
Annelida	21.7	4.6	5.1
Allolobophora	17.4	2.9	3.1
Totals	23	861	156.2

Items below 1% by number: Coleoptera: *Pterostichus*, *Pseudophonus rubescens*, *Calathus*, *Agonum*, *Harpalus*, *Polyphylla*, *Pentodon idiota*, *Silpha*, *Sitona*, *Cleonus*, *Plagionotus floralis*, Lampyridae, *Cicindela campestris*, Staphylinidae and Staphylinidae larvae, Dermestidae; Hymenoptera: *Formica*, *Lasius*, *Halictus*, Braconidae; Orthoptera: *Aiolopus thalassinus*, *Decticus*, *Conocephalus discolor*, *Melanophrys desertus*; Hemiptera: Miridae, Rhopalidae, Coreidae, Reduviidae, *Sigara*; Lepidoptera: Tortricidae; Annelida: *Allolobophora caliginosa*, *Dendrobaena*, *Octodrillus*, *Eiseniella*, *Eisenia*; Arachnida; Mollusca: Monachinae, Bivalvia; Crustacea: *Upogebia pusilla*; Osteichtyes: *Atherina*, *Spratus*; Plant material: olives; Other material: meat, plastic, stones.

Appendix III

Food items in carcass stomachs of Mediterranean Gull chicks.

Type of food	Frequency			% Number		
	1986	1987	1988	1986	1987	1988
Insecta	66.7	78.9	92.9	61.8	58.5	94.4
Coleoptera	38.9	63.2	78.6	31.4	16.8	71.0
Melolonthidae	50.0	47.4	50.0	22.9	13.5	24.5
Polyphylla	22.2	—	28.6	7.1	—	4.1
Anomala	22.2	47.4	21.4	15.4	13.5	20.4
Carabidae	16.7	10.5	42.9	7.9	1.5	41.3
Ophonus	5.5	—	14.3	1.4	—	23.4
Amara	—	5.3	—	—	1.3	—
Curculionidae	5.5	5.3	14.3	6.1	0.2	1.5
Scarabaeidae	—	10.5	—	—	1.1	—
Pentodon idiota + sp.	—	10.5	—	—	1.1	—
Elateridae	—	5.3	7.1	—	0.2	1.5
Hymenoptera	—	10.5	28.6	—	35.5	17.5
Hemiptera	33.3	10.5	7.1	27.5	0.9	0.4
Eurygaster maura + sp.	27.8	5.3	—	27.2	0.7	—
Formicidae	—	10.5	21.4	—	35.5	16.7
Formica rufa	—	—	14.3	—	—	16.0
Orthoptera	27.8	36.8	28.6	2.1	5.0	5.6
Caliptamus italicus	—	—	7.1	—	—	3.7
Gryllotalpa gryllotalpa	—	36.8	7.1	—	5.0	0.4
Mollusca	50.0	42.1	50.0	33.9	40.2	3.7
Gastropoda	11.1	36.8	7.1	30.7	39.4	1.5
Helicellinae	11.1	36.8	7.1	30.7	36.8	1.5
Monachinae	—	10.5	—	—	2.6	—
Bivalvia	38.9	10.5	42.9	3.2	0.7	2.2
Plant material	50.0	21.0	21.4	3.2	0.8	1.1
Wheat	50.0	15.8	21.4	3.2	0.6	1.1
Totals	18	19	14	280	535	269

Items below 1 % by number (in parenthesis is the year of occurence): Coleoptera: *Harpalus* (1986), *Curculio* (1986), Silphidae (1986); Diptera (1987); Hemiptera: *Cicada* (1986); Curstacea: Isopoda (1988); Mollusca: *Monacha* (1987); Bivalvia: Tellinidae (1987), *Spisula subtruncata* (all years); Osteichthyes (1986—87); Mammalia: *Rattus* (1987); other Vertebrata (1986—87); Plant material: peanuts (1987); Other material: metal (1987), stones (all years).