FORAGING BEHAVIOR AND ANALYSIS OF WHOLE PREY EATEN BY THE AMERICAN OYSTERCATCHER (*HAEMATOPUS PALLIATUS*)

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Abstract

As part of a continuing study using the American oystercatcher (*Haematopus palliatus*), populations as biomonitors of coastal habitat quality[6], foraging behavior was quantified, and primary food items obtained for nutritional analysis during June and July, 2002. Two southeastern US barrier island sites were sampled: St. Catherines Island (SCI), GA and Cape Romain National Wildlife Refuge, SC. Bivalves including blood ark clams (*Anadara ovalis*), Eastern oyster (*Crassostrea virginica*), and false angel wings (*Petricola pholadiformis*) were identified as prey items, along with knob whelk (*Busycon carica*). These marine invertebrate species were subject to whole prey analysis including proximate composition (water, crude protein, crude fat, and ash), fat-soluble vitamins A and E, and mineral content. Water content of meat from the whelk (73.4 ± 1.7%) and larger bivalves (oysters and blood arks; 79.9 ± 0.3 to 83.8 ± 0.5%) was higher than that of tiny false angel wings (60.0 ± 2.0 to 62.9 ± 5.8%); the latter were consumed with the shell intact. Fat content ranged from 6.5 ± 0.1% in false angel wings to 14.7± 1.4% (dry matter, DM, basis) in Eastern oysters, and fat content was quite variable in oyster samples collected from SCI. *C. virginica* had the highest vitamin A and E values, while *P. pholadiformis* had the highest Ca. Foraging activity may be affected by height of tide, human disturbance, as well as seasonal food quality and availability. This summary of foraging and whole prey nutrition data establishes baseline values for future comparisons and guidelines for captive feeding programs.

Introduction

The American oystercatcher (*Haematopus palliatus)* is a shorebird species with a range along the Atlantic coast from Massachusetts south to Mexico[5]. American oystercatchers (AMOY) are easily recognized by their black and white, chunky bodies, bright orange eyes and bright orange knifelike bill they use to feed on marine invertebrates at low tide. AMOY are important for coastal ecosystem conservation as a charismatic, highly visible species and as shellfish consumers, bio-indicators of ecosystem health[6]. Populations of the AMOY are threatened by human disturbance as well as habitat destruction and degradation[5]. Human disturbance causes birds to expend unnecessary energy in flight, and scares them away from feeding sites, which can aversely affect health and reproduction[4].

AMOY exhibit distinctive feeding behavior when they forage on partially submerged oysterbeds at low tide. Oyster shells are slightly opened as the bivalves filter-feed. When an AMOY spots an open shell, it quickly jams its long narrow bill into the oyster, severing the adductor muscles to expose soft parts which are then eaten[5]. However, little data are available on prey species that

AMOY consume in coastal areas of the Southeastern U.S and on nutritional analysis of these whole prey items. The published literature that can be found for shellfish focuses on species and portions for human consumption, not necessarily the same as those consumed by oystercatchers[2]. Observations of American oystercatcher foraging behavior and prey species are summarized here, along with chemical composition of analyzed whole prey items. These data can be used by wildlife managers to gain a better understanding of prey consumption for populations in the wild, as well as nutritional implications for captive animals.

Methods

Observations and Sample Collection. Foraging was examined at two study locations: St. Catherines Island, GA and Cape Romain National Wildlife Refuge, SC, along beach feeding sites for 2 hours each day at low tide. Birds were observed with binoculars at approximately 15 m, following flight distance suggestions[4]; prey items consumed were identified and feeding behaviors documented. Samples for nutritional analysis were collected based on abundance, availability and observed/suspected consumption, and chilled on ice until processing. Meat was removed from shells unless observations indicated consumption included shell; subsamples were pooled by site into plastic bags and kept frozen (-70ºC) until laboratory analysis.

Nutritional Analysis. Frozen samples were partially thawed and ground using a food processor in the Bronx Zoo Nutrition Laboratory, Bronx, NY. Proximate composition (water, ash, crude fat and crude protein) as well as vitamins A and E extraction and analysis followed previously cited methods for meat samples[1]. Macro- and trace minerals were assayed via inductively coupled plasma-mass spectrometry or atomic absorption (Se only) at the Laboratory for Large Animal Pathology and Toxicology (University of Pennsylvania, Kennett Square, PA).

Results and Discussion

Foraging Behavior. AMOY fed opportunistically upon invertebrate species available at low tide including blood ark clams (*Anadera ovalis*), Eastern oysters (*Crassostrea virginica),* false angel wings (*Petricola pholadiformis*), and knob whelks (*Busycon carica).* Foraging appeared to be primarily visual. The birds employed different techniques for prey species present on beach substrates including mud, sand, or oyster reefs. Availability of a particular substrate and associated species was related to the height of the tide, as AMOY were observed only to venture out into leg-deep water. Consumption of hard-shelled bivalves including blood arks and oysters on the reef substrate involved a technique of jamming the beak inside the edge of an open bivalve’s shell, severing the adductor muscles, and pulling out the meat. Selected oysters tended to be 4-5 cm in length. False angel wings were consumed by either probing air holes in mud flats with the bill, and removing the soft-shelled bivalves from their burrows prior to swallowing through wriggling motions, or by visually “stalking” holes prior to a sudden rapid immediate stab/pluck. With both techniques, AMOY consumed the false angle wings including the shell. Knob whelks were flipped over on the sand, and contents removed and swallowed. However, it was unclear whether the birds were specifically consuming the whelk itself, or possibly hermit crabs living in empty shells.

Nutritional Analysis. Proximate composition and vitamin data of food items collected are found in Table 1, whereas mineral constituents analyzed are found in Table 2. Foods eaten by the AMOY were moderate to high in protein content, and moderate to low in crude fat. With the exception of whelk muscle (vitamin A only), all foods appeared to contain adequate to high concentrations of vitamins A and E compared to NRC requirements of these nutrients for either avian species or domestic carnivores[8]. Oysters were particularly high in fat-soluble vitamins; this may vary seasonally but has not been examined to date. Nutritional content of oysters, as described by a condition index, is closely linked with reproductive cycles; the index is high in winter and lower in summer once spawning has occurred[7]. In this region of the southeastern US coast, oyster spawning occurs primarily in July and August and continues until October[3]. The pre-spawning mature oysters (that should have the highest nutritional [glycogen] content) are available in March through June. The samples of *C. virginica* analyzed in this study were collected in mid- to late June and may be representative of higher oyster nutritional content at that time. It is important to note, however, that the gonadal stages of collected oysters in this study were not identified at the time sampled, thus could vary from the general spawning time scale due to temperature and salinity differences at study sites.

Of more interest, perhaps, are the minerals measured in these aquatic invertebrates, and particularly calcium content. Clearly, species consumed with the shell (false angel wings) supply high levels of dietary Ca (approx. 20% of DM) to the AMOY. In this study, however, even raw oyster and clam meat contained 3 to 11 times more Ca than P, and 10 to 30 times more Ca compared to oyster and clam meat prepared for human consumption[8]. Regarding trace elements, Fe, Se, and Zn seemed particularly high in many of the invertebrates sampled. While in some cases this may be attributed to the inclusion of shell in the false angel wing samples, some of the highest mineral concentrations were found in meat-only samples (i.e. Zn in oysters). Between sites, both the oysters and the false angel wings varied consistently, with samples from Cape Romain containing a higher Cu content that may be indicative of significant habitat discrepancies that remain to be investigated. From these data, minimum mineral nutritional needs would appear to be met by the invertebrates analyzed; excesses, imbalances, or toxicities may be more of a concern than deficiency.

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Table 1. Proximate nutrient composition and vitamins A and E (x ± SD) of aquatic invertebrates collected June/July 2002 from St. Catherine's Island,GA (SCI) and Cape Romain National Wildlife Refuge, SC (CRNWR), eaten by American oystercatchers (*Haematopus palliatus*). For all samples n=2, except for Eastern Oyster-SCI where n=3 and * (n=1); all data (except water) reported on a dry matter (DM basis).

Sample	**Location**	**Water** %	**Crude Protein** % DM	**Crude Fat** % DM	**Ash** % DM	**Vit A** IU/kg	**Vit E** IU/kg
Blood Ark *Anadera ovalis*	SCI	79.86 ± 0.03	59.47 ± 2.76	8.86 ± 0.14	19.16 ± 0.24	28057.5 ± 29862.3	99.44 ± 34.65
Eastern Oyster *Crassostrea virginica*	SCI	79.86 ± 0.25	48.87 ± 5.27	9.80 ± 4.81	26.60 ±4.28	34327.7 ± 25752.3	191.76 ± 20.62
Eastern Oyster *C. virginica*	CRNWR	83.80 ± 0.46	46.50 ± 3.47	14.65 ± 1.51	36.14 ± 8.96	34921.08± 3899.47	285.23 ± 11.26
Knob Whelk *Busycon carica*	SCI	73.35 ± 1.67	59.95 ± 1.55	10.55 ± 2.84	11.78 ± 2.45	3365.7*	118.18 ± 15.32
False Angel Wings (w/ shell) *Petricola pholadiformis*	SCI	62.94 ± 5.82	13.74 ± 0.33	6.52 ± 0.14	77.48 ± 2.46	10617.33± 4285.17	58.86 ±18.09
False Angel Wings (w/ shell) *P. pholadiformis*	CRNWR	60.02 ± 2.02	13.10 ± 0.80	7.64 ± 1.19	79.54 ± 2.02	29183.98 ± 551.83	71.61 ± 14.18

Table 2. Minerals (x ± SD) in aquatic invertebrates collected June/July 2002 from St. Catherine's Island,GA (SCI) and Cape Romain National Wildlife Refuge, SC (CRNWR), eaten by American oystercatchers (*Haematopus palliatus*). For all samples n=2, except for Eastern Oyster-SCI where n=3. All values listed in mg/kg on a dry matter basis.

		Ca	**K**	**Mg**	**Na**	**P**	**Cu**	**Fe**	**Mn**	**Se**	**Zn**
Blood Ark *Anadera ovalis*	SCI	16100 ± 5374.01	12050 ± 353.55	4005 ± 77.78	20050± 494.97	6320 ± 70.71	2.72 ± 0.03	688 ± 26.87	27.05 ± 0.07	3.00 ± 0.11	107 ± 0.00
Eastern Oyster *Crassostrea virginica*	SCI	44333.33 ± 30185.48	12033.33 ± 1078.58	3570 ± 377.49	22033.33 ± 2193.93	7163.33 ± 735.82	29.63 ± 1.65	458 ± 83.43	24.03 ± 0.9	2.00 ± .05	453 ± 43.27
Eastern Oyster *C. virginica*	CRNWR	67150 ± 17606.96	11400 ± 707.11	4540 ± 721.25	27300 ± 2969.85	6065 ± 289.91	69.95 ± 3.32	959 ± 213.55	47.6 ± 8.06	2.65 ± 0.52	625 ± 19.8
Knob Whelk *Busycon carica*	SCI	6525 ± 487.90	9255 ± 728.32	6705 ± 813.17	9275 ± 2156.58	4840 ± 183.85	10.935 ± 3.06	118 ± 16.97	11.705 ± 3.25	1.045 ± 0.32	172.4 ± 118.23
False Angel Wings (w/ shell) *Petricola pholadiformis*	SCI	211500 ± 13435.03	3950 ± 70.71	2070 ± 56.57	12350 ± 212.13	2460 ± 169.71	3.925 ± 1.52	1670 ± 113.14	17 ± 1.41	1.035 ± 0.13	13.75 ± 0.49
False Angel Wings (w/ shell) *P. pholadiformis*	CRNWR	194500 ± 707.11	4085 ± 912.17	2425 ± 403.05	13550 ± 2474.87	2030 ± 579.83	9.485 ± 1.44	3265 ± 77.78	23.15 ± 0.35	1.08 ± 0.2	15.8 ± 2.97