

## Composition of food remains of the Gyrfalcon (*Falco rusticolus*) in the northeastern Iceland

### Složení zbytků potravy sokola loveckého (*Falco rusticolus*) na severovýchodním Islandu

MLÍKOVSKÝ J.

Dipl.-Biol. Jiří Mlíkovský, CSc., Vršovická 11, 101 00 Praha 10, Czech Republic;  
e-mail mlik@post.cz

**ABSTRACT.** Composition of food remains of the Gyrfalcon was studied in northeastern Iceland in July 1998. All remains belonged to medium-sized sea birds, particularly to Kittiwakes, Northern Fulmars and Guillemots. Among prey remains, wing bones, sterna, coracoids, and scapulae markedly outnumbered hindlimb bones, which reflects the mode of prey consumption.

It has long been recognized that avian predators can accumulate a considerable amount of bone remains (STEENSTRUP 1872, NEHRING 1879, 1889). The composition of these remains is known to differ between major taxa of predators (MOURER-CHAUVIRÉ 1983, ERICKSON 1987, HOFFMAN 1988, LIVINGSTON 1989, ANDREWS 1990, BAALES 1992, see also KORTH 1979), but detailed observations on the composition of bony lefovers, and on the preservation of bone remains in modern owls and raptors are rarely reported. As regards remains of the avian prey, more or less detailed studies were published only for White-tailed Sea Eagles (MLÍKOVSKÝ 1992, 1996), and several owl species (BOCHENSKI et al. 1993, BOCHENSKI & TOMEK 1994, BOCHENSKI 1997). Below, I present data on the composition and preservation of avian remains found in the diet of the Gyrfalcon.

The material was collected on 26 July 1998 at two localities in the Norur-íngeyjar Province in northeastern Iceland: (1) Ásbyrgi (ca. 66° 00' N, 16° 30' E) is an inland canyon surrounded with up to 100 m high cliffs. A breeding colony of Northern Fulmars (*Fulmarus glacialis*) is located on these cliffs. Remains of Gyrfalcon prey were found concentrated on a low heap of stones in a small lake near the blind end of the canyon. (2) Raudinúpur (ca. 66° 30' N, 16° 30' E) is a bird cliff at the northwestern corner of the Norur-íngeyjar Province. Prey remains of Gyrfalcons were found scattered along the rocky shore, below the breeding colony of sea birds. Most of the carcasses and skeletons found were complete or almost complete, did not show any traces of predator impact, and apparently originated from naturally deceased birds. They were left unconsidered in the present study. On the other hand, many skeletal remains had typical marks from predator impact. Of them, abundant remains of Kittiwakes (*Larus tridactylus*) were not studied (one was taken as an example), while all such remains of the Procellariidae and Alcidae were collected. The Kittiwakes were excluded from the study for technical reasons. The time I was able to spend at the locality was too short for counting all Kittiwake bones, and the material was too voluminous to be transported away.

The material could be unequivocally attributed to Gyrfalcons, because no other species of raptorial birds occur in northwestern Iceland (CRAMP 1980, 1985, del HOYO et al. 1994), and the carcasses lacked any marks of activity of potential scavengers, such as Great Skua *Catharacta skua* or Polar fox (*Alopex lagopus*) (cf. KORTH 1979, ANDREWS 1990). Unfortunately, I was not able to observe Gyrfalcons on Iceland.

### Food of Gyrfalcons

All prey remains found at Ásbyrgi belonged to Northern Fulmars. A moderate number of these birds bred at the locality, providing thus a suitable food source for Gyrfalcons. The only other medium-sized bird species that occurred in the canyon was European Wigeon (*Anas penelope*). Its remains were not found, but the very small amount of prey remains collected precludes any hypothesis that local Gyrfalcons were specialized fulmar hunters.

Diet of Gyrfalcons was more variable at Raudinúpur. The record included many Kittiwakes (not counted), 9 Guillemots (*Uria aalge*), 2 Common Puffins (*Fratercula arctica*), and 2 Northern Fulmars. All these birds bred in large numbers on the cliffs. Two other species of birds of suitable size occurred at Raudinúpur in large numbers, including Eiders (*Somateria mollissima*) and Purple Sandpipers (*Calidris maritima*), but were not recorded in the diet of Gyrfalcons. This may indicate that local Gyrfalcons preferred cliff-breeding birds as their prey.

### Composition of food remains

The composition of food remains of Gyrfalcons collected at Ásbyrgi and Raudinúpur is given in Table 1. The leftovers almost invariably included wing and shoulder bones, while pelvis and hind limbs were missing. At Raudinúpur I found a freshly killed Kittiwake, opened by a Gyrfalcon (this specimen was not included in Table 1). Its head was torn off (lying next to the carcass), and the gull was opened from the left side under the wing. Parts of its sternal musculature and viscera were eaten, but the bird was not plucked.

The available observations allow for the following reconstruction of the feeding habits of Gyrfalcons. The prey (a medium-sized bird) is caught and brought to a feeding site, where its head is torn off. Then the Gyrfalcon opens a flank of the prey, and eats its viscera and sternal muscles. Subsequently the Gyrfalcon swallows the head, pelvis and hind limbs of its prey (sequence of these actions remains unknown). Flesh is picked off from the prey's wings (10 of 11 sterna were damaged by this action), but wing bones, sternum, furcula and coracoids remain unswallowed. Gyrfalcons may have a preferred place where to feed on their prey (Ásbyrgi), or always feed on a different place, though of a given type (Raudinúpur).

In this way, forelimb bones markedly outnumber hindlimb bones when leftovers of Gyrfalcon's prey are collected. At the same time, the numbers of stylopodial, zeugopodial and autopodial bones are similar to each other. This agrees with the data on the White-tailed Sea Eagle (*Haliaeetus albicilla*) (MLÍKOVSKÝ 1992, 1996). However, the bones tended to be more frequently broken in the food of White-tailed Sea Eagles than in the food of Gyrfalcons. Overall, 5.3 % of main wing bones (humerus, ulna and carpometacarpus) were broken in the diet of White-tailed Sea Eagles (n = 394;

MLÍKOVSKÝ 1996), while none were broken in the diet of Gyrfalcons (n = 76; this paper).

## SOUHRN

Složení zbytků potravy sokola loveckého bylo studováno na severovýchodním Islandu. Poblíž hnízdních kolonií mořských ptáků v Ásbyrgi a Raudinúpuru se sokoli živili převážně buřňáky severními, alkouny úzkozobými a racky tříprstými. Ve zbytcích potravy výrazně převažovaly kosti křídel a ramenního pletence. Podle nálezu jednoho čerstvě načatého racka tříprstého a kosterních pozůstatků lze soudit, že sokol kořist po ulovení odnese na místo zpracování, tam jí utrhne hlavu a napřed sežere prsní svaly a vnitřnosti, aniž by předtím kořist oškubal. Pak sežere hlavu, krk, pánev a zadní nohy kořisti, zatímco křídla a ramenní pletenec jen ozobe a nechá ležet na místě.

**Table 1** - Composition of avian remains from the food of Gyrfalcons in northeastern Iceland. A - whole bones, B - bone fragments.

**Tab. 1** - Složení zbytků ptáků z potravy sokola loveckého na severovýchodním Islandu. A - celé kosti, B - zlomené kosti.

	Raudinúpur								Ásbyrgi		Total		
	Uria		Fraterecula		Larus		Fulmarus		Fulmarus		A	B	%B
	A	B	A	B	A	B	A	B	A	B			
Coracoid	15	-	4	-	2	-	1	-	4	-	26	0	0
Scapula	6	8	2	2	-	2	1	-	4	-	13	12	48.0
Furcula	4	3	-	-	-	1	1	-	1	1	6	5	45.5
Sternum	7	-	2	-	1	-	-	-	1	-	11	-	0
Humerus	15	-	4	-	2	-	1	-	4	-	26	-	0
Ulna	14	-	4	-	2	-	1	-	4	-	25	-	0
Radius	14	-	4	-	2	-	1	-	4	-	25	-	0
Carpometacarpus	14	-	4	-	2	-	1	-	4	-	25	-	0
Phalanx I dig. maj.	13	-	4	-	2	-	1	-	4	-	25	-	0
Femur	1	-	-	-	-	-	-	-	-	-	1	-	0
Tibiotarsus	1	-	-	-	-	-	-	-	-	-	1	-	0
Tarsometatarsus	1	-	-	-	-	-	-	-	-	-	1	-	0
H+U+CMC	43	-	12	-	6	-	3	-	12	-	76	-	0
F+TT+TMT	3	-	-	-	-	-	-	-	-	-	3	-	0
Total	105	11	28	2	13	3	8	-	30	1	184	17	8.5

## REFERENCES

- ANDREWS, P. 1990: Owls, caves and fossils. - *Natural History Museum, London*.
- BAALES, M. 1992: Accumulations of bones of Lagopus in late Pleistocene sediments. Are they caused by man or animals? - *Cranium*, 9: 17-22.
- BOCHENSKI, Z.M. 1997: Preliminary taphonomic studies on damage to bird bones by Snowy Owls *Nyctea scandiaca*, with comments on the survival of bones in paleontological sites. - *Acta zool. cracov.*, 40: 279-292.
- BOCHENSKI, Z.M. & TOMEK, T. 1994: Pattern of bird bone fragmentation in pellets of the Long-eared Owl *Asio otus* and its taphonomic implications. - *Acta zool. cracov.*, 37: 177-190.
- BOCHENSKI, Z.M., TOMEK, T., BOEV, Z. & MITEV, I. 1993: Patterns of bird bone fragmentation in pellets of the Tawny Owl (*Strix aluco*) and the Eagle Owl (*Bubo bubo*) and their taphonomic implications. - *Acta zool. cracov.*, 36: 313-328.
- CRAMP, S. (Ed.) 1980: The birds of the western Palearctic. Vol. 2: Hawks to bustards. - *Oxford University Press, Oxford*.
- CRAMP, S. (Ed.) 1985: The birds of the western Palearctic. Vol. 4: Terns to woodpeckers. - *Oxford University Press, Oxford*.
- DEL HOYO, J., ELLIOTT, A. & SARGATAL, J. (Eds.) 1994: Handbook of the birds of the world. Vol. 2: New World vultures to guineafowl. - *Lynx Editions, Barcelona*.
- ERICKSON, P.G.P. 1987: Interpretations of archaeological bird remains: A taphonomic approach. - *J. archaeol. Sci.*, 14: 65-75.
- HOFFMAN, R. 1988: The contribution of raptorial birds to patterning in small mammal assemblages. - *Paleobiology*, 14: 81-90.
- KORTH, W.W. 1979: Taphonomy of microvertebrate fossil assemblages. - *Ann. Carnegie Mus.*, 48: 235-285.
- LIVINGSTON, S.D. 1989: The taphonomic interpretation of avian skeletal part frequencies. - *J. archaeol. Sci.*, 16: 537-547.
- MLÍKOVSKÝ, J. 1992: Population status and food of the White-tailed Fish Eagle *Haliaeetus albicilla* (Aves: Accipitridae) in the Svjatoj Nos wetlands, Lake Baikal. - In: MLÍKOVSKÝ, J. & STÝBLO, P. (Eds.): *Ecology of the Svjatoj Nos wetlands, Lake Baikal*. - *Ninox Press, Praha*: 79-88.
- MLÍKOVSKÝ, J. 1996: New data on the food of the White-tailed Sea Eagle (*Haliaeetus albicilla*) in the Svjatoj Nos wetlands, Lake Baikal. - *Buteo*, 8: 115-118.
- MOURER-CHAUVIRÉ, C. 1983: Les oiseaux dans les habitats paléolithiques: gibier des hommes ou proies des rapaces? - In: GRIGSON, C. & CLUTTON-BROCK, J. (Eds.): *Animals and archaeology: 2. Shell middens, fishes and birds*. - *BAR int. Ser.*, 183: 111-124.
- NEHRING, A. 1879: Die Raubvögel und die prähistorischen Knochenlager. - *Corr.-Bl. deutsch. Ges. Anthropol., Ethnol. Urgeschichte*, 8: 57-59.
- NEHRING, A. 1889: Der Transport tierischer Reste durch Vögel und seine Bedeutung für Geologie und Paläontologie. - *Naturwiss. Wochenschr.*, 4: 233-235.
- STEENSTRUP, J.J.S. 1872: On de maerker, som knoklerne i fuglenes ophulkede foderboller baere af opholdet i fuglenes maver samt om disse maerkers betydning for geologien og archaeologien. - *Vidensk. Medd. nat. Foren. Kjøbenhavn*, 4: 213-236.

(Received 25.8.1998, accepted 15.11.1998)