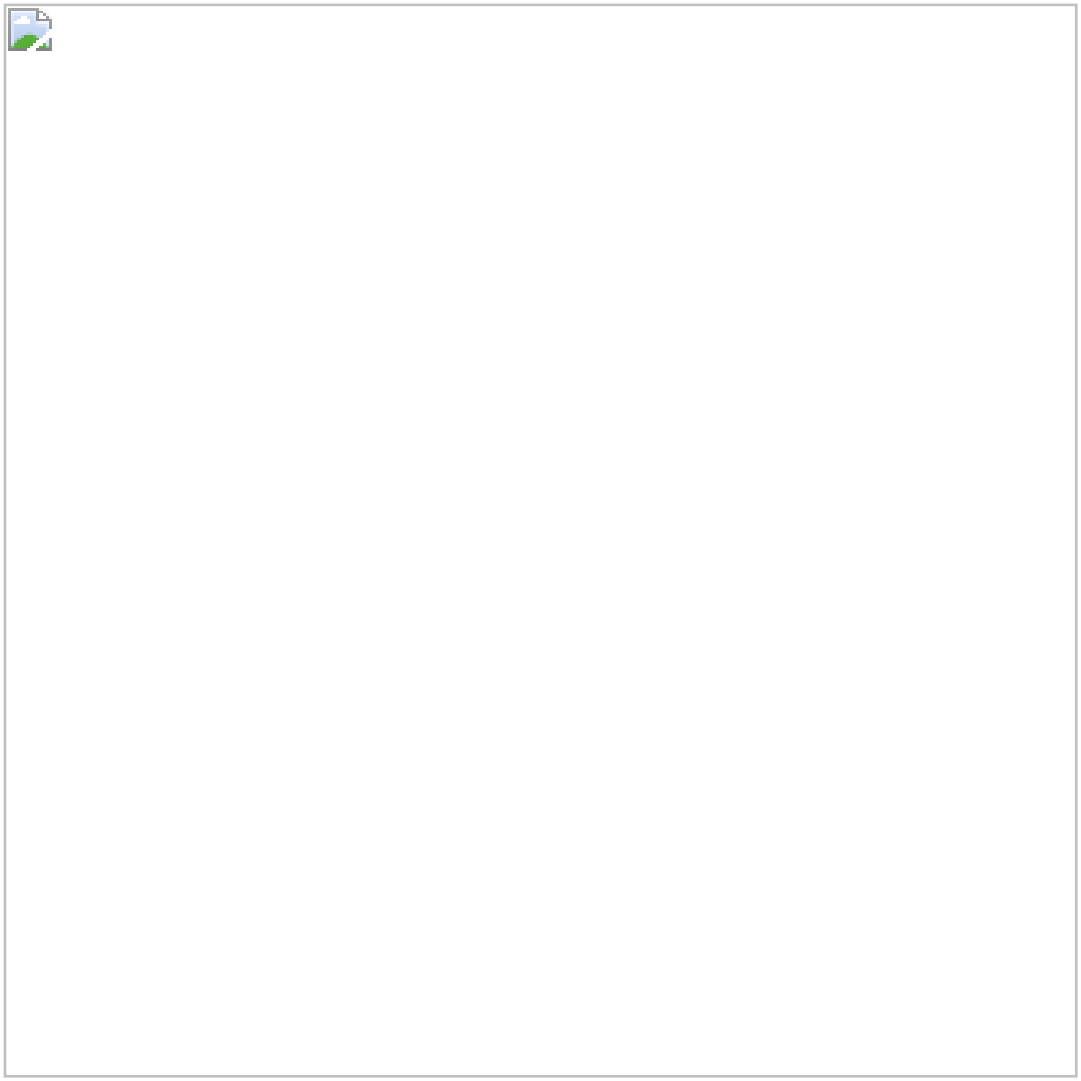

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Intestinal Microflora of Young Greater Flamingos (*Phoenicopterus ruber roseus* Pallas) in the Camargue

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The greater flamingo (*Phoenicopterus ruber roseus*) has increased in the south of France to such an extent that it has become one of the most abundant aquatic bird species in the Camargue and neighbouring regions, particularly during the summer. At times they occur on practically all the shallower brackish lagoons and salt pans, and even venture into the fresh water areas, often in the vicinity of human inhabitations. As part of a study on the movements and other biological and ecological aspects of the greater flamingos breeding in the Camargue, a sample of the chicks born in 1977 was captured and marked with a series of PVC leg-bands (Hafner et al., 1979, Terre Vie, Rev. Ecol. 33: 307–324). Since they may represent a source and/or reservoir of bacteria for man and other animals, a study was conducted to identify the normal microflora of wild flamingos.

During the marking operation, 54 cloacal swabs and three samples of regurgitated food were obtained from young flamingos. Six chicks accidentally died while being held captive in the enclosure and specimens were collected from the proventriculus, upper and lower intestine and cecum, and from three of the six bile samples. All the birds were from 6 to 8 wk of age.

Unless otherwise indicated, the bacteria were isolated by standard methods and classified according to the Bergey's Manual (Buchanan and Gibbons, 1974, Bergey's Manual of Determinative Bacteriology, Williams and Wilkins Co., Baltimore, Maryland, 1,246 pp.). The enrichment broths used for the Gram negative bacteria were: sodium selenite, Salmonella/Shigella sodium deoxycholate medium and EMB agar (Institut Pasteur Production, Paris, France). *Escherichia coli* Type 1 was identified from the other coliforms on the basis of lactose fermentation at 44.5 C (±0.5 C) with indol and gas production. *Proteus* species were further characterized by the reaction in maltose peptone water and the ability to produce indol. The strain of *Edwardsiella hoshinae* was kindly identified by Dr. C. Richard (Service des Enterobacteries, Institut Pasteur, Paris, France). *Micrococcus* isolated on Chapman medium were coagulase, mannitol and glucose tested and were identified according to the classification of Mossel and Martin (1961, Ann. Inst. Pasteur Lille 12: 225–226). *Streptococcus* strains belonging to the *Enterococcus* group were identified by biochemical characters after isolation on Slanetz Medium (Institut Pasteur Production, Paris, France). No anaerobic cultures were made.

The results are given in Table 1. Some bacteria could be found at all levels of the digestive tracts, for example *Escherichia coli* Type 1 and other coliforms as well as *Streptococcus faecalis*, *Streptococcus faecium* and *Salmonella typhimurium* (the latter found in only 2 of the 6 dead birds), whereas others appear to be confined to the terminal digestive tract. In any case, practically all of those found occurred in the terminal digestive tract. None of the six dead birds showed macroscopic lesions at necropsy. Most of the 54 sampled birds have been seen alive many times since.

The bacteria found in these flamingo chicks could have originated either from contact with the parents or other species frequenting the same habitat. The water salinity (up to 100 g/liter NaCl) could act as selective factor for certain species of bacteria. In birds, the microflora of the alimentary tract is established shortly after hatching (Smith, 1965, J. Pathol. Bacteriol. 90: 495–513; Mead and Adams, 1975, Brit. Poult. Sci. 16: 169–176). The early feeding of chicks by the adults probably insures the transfer of many of the organisms from the adult flamingo's gastrointestinal tract to the chick.

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TABLE 1. Bacteria isolated from different areas of the gastrointestinal tracts in young greater flamingos.

Species	Digestive tract areas				
	Proventriculus regurgitated food	Upper intestine	Lower intestine	Ceca and cloaca	Bile
Salmonella typhimurium lys. 29	2/6[a]	2/6	2/6	2/6	
Escherichia coli Type 1	5/6	5/6	5/6	20/54	1/6
Other coliforms	2/6	2/6	2/6	3/6, 20/54	
Enterobacter hafniae		1/6	1/6	3/6, 3/54	3/3
Enterobacter cloacae			1/6		
Alcaligenes fecalis	3/6			20/54	
Citrobacter sp.		1/6		10/54	
Edwardsiella tarda			1/6		
Edwardsiella hoshinae	1/6	1/6	1/6	1/6, 20/54	
Proteus vulgaris				30/60	
Proteus mirabilis				20/60	
Pseudomonas maltophilia	3/6	1/6		1/6, 20/54	
Vibrio non agglutinable NAG		2/6		2/6	
Pleisiomonas shigelloides				20/54	
Streptococcus faecalis	1/6	1/6	3/6	5/6, 44/54	1/3
Streptococcus faecium	2/6	3/6	3/6	5/6, 34/54	1/3
Staphylococcus epidermidis 1-4			1/6		
Staphylococcus epidermidis 5		1/6			
Staphylococcus sp.			1/6	3/6	
Micrococcus sp.		1/6	2/6	2/6	

[a] No. isolations/no. examined.

Wood and Trust (1972, Can. J. Microbiol. 18: 1577–1583) found the same situation in the glaucous-winged gull (*Larus glaucescens*). Young flamingos live in "creche" numbering up to several thousand birds in the same pond and as a result, probably have a common microflora.

In comparison with the microflora found in other wild birds practically the same species of bacteria were recorded by Cragg and Clayton (1971, J. Clin. Pathol. 24: 317–319), Radwan and Lampky (1971, Avian Dis. 16: 343–350), Wood and Trust (1972, op. cit.) in different bird species, and in the Camargue herring gull (*Larus argentatus michahellis*) which frequent the same areas as the flamingos (Rollin et al., 1982, Avian Path., in press). *Edwardsiella tarda* also recorded in gulls (Berg and Anderson, 1972, Appl. Microbiol. 24: 501–503) have never been incriminated in pathology of wild birds. *Edwardsiella hoshinae* was also isolated from another bird *Fratercula arctica*, from reptiles *Varanus* sp. and from water (Grimont et al., 1980, Curr. Microbiol. 4: 347–351).

Although the flamingos examined seemed to be in good health, some of the bacteria found could have pathological significance. Humphreys (1975, *In* Flamingos, Kear and Duplaix Hall (eds.), Poyser, Berkhamsted, England, pp. 199–202) found that flamingos are subject to salmonellosis, streptococcal septicemia and staphylococcal synovitis in captivity, but states that these diseases appear to be exceptional. Septicemia occasionally arises from infected lesions from legs and feet. Infectious diseases are not a mortality factor in the wild birds in Camargue.

Some of the bacteria (e.g., *Escherichia coli* and *Streptococcus faecalis*) are used as indicator organisms to evaluate fecal pollution of water for public health purposes. These bacteria occur as "normal" flora of flamingos and other avian species which are frequently in close contact with man (Zoucek and Mushin, 1970, Appl. Microbiol. 20: 561–566) as in the present situation with flamingos. Movements by hundreds or even thousands of birds from pond to pond could contribute to the spread of "fecal" pollution. The species found in this study form only a part of the flamingo's bacterial flora and further investigations need to be carried out specially for mycobacteria and anaerobic species.

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