SEXUAL DIFFERENCES IN LEVELS OF BLOOD CAROTENOIDS IN CIRL BUNTINGS *EMBERIZA CIRLUS*

JORDI FIGUEROLA[1, 3] & RICARD GUTIÉRREZ[2]

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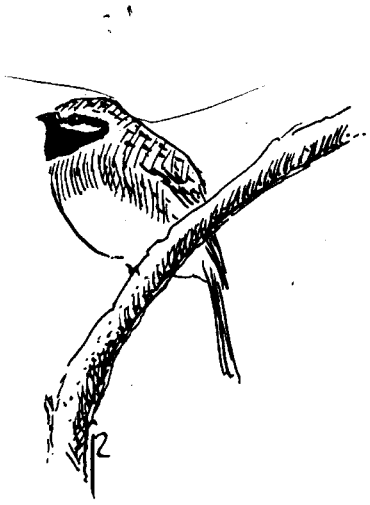

Carotenoids are responsible for the bright red and yellow plumage of birds. These substances cannot be synthesised by birds and must be obtained from the diet and transported through the blood to the feathers. The carotenoid content of blood was measured in Cirl Buntings *Emberiza cirlus*, a species with sexually dimorphic yellow plumage. Carotenoid concentration, estimated from the coloration of the plasma, was higher in males than in females and juveniles. These differences were unrelated to the greater incidence of feather moult in males. Although the reasons for the differences are not understood, the results of this and two previous studies suggest that, in species with sexually dichromatic plumage, the quantity of carotenoids transported in the blood is higher in the more brightly coloured sex.

Key words: *Emberiza cirlus* - carotenoids - passerines - plumage brightness - sexual dimorphism - sexual attractiveness

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Many of the sexual differences in plumage coloration of birds result from the occurrence of carotenoid-derived colours in males (Gray 1996). Bright yellow, orange, red and violet colorations are produced by the accumulation of carotenoids in feathers (Brush 1978). Unlike other plumage pigments such as melanin, carotenoids cannot be synthesised by birds, and have to be obtained from the bird's diet (Brush 1978, 1990; Goodwin 1984). After ingestion, carotenoids are transported from the digestive tract to the developing feathers via the blood (Fox 1962). Different studies have shown that females prefer to mate with brightly plumaged males (i.e. Hill 1991). A relationship between the quantity of carotenoids in the blood (estimated from the coloration of the plasma) and the brightness of the developing plumage, as well as sexual differences in carotenoid concentrations, have been reported in the House Finch *Carpodacus mexicanus* (Hill *et al.* 1994). A similar sex-specific pattern of carotenoid content in the blood occurs in the Northern Cardinal *Cardinalis cardinalis*, also a species with a red carotenoid-derived and a sexually dimorphic plumage (Hill 1995a). Red and yellow plumages seem to be produced by different kind of carotenoids (i.e. Brush & Power 1976; Hudon & Brush 1992), but up to now no study has examined the sexual differences in blood carotenoid content in a yellow-plumaged sexually dimorphic species. In this paper we compare the plasma coloration of male, female and juvenile Cirl Bunting *Emberiza cirlus*, and provide the first evidence of sexual differences in plasma coloration in a species with sexually dimorphic yellow plumage.

The Cirl Bunting is a 15.5 cm long passerine weighing about 25 g. It is widely distributed throughout southern Europe and NW Africa

titles); the continuation of Wiek en Sneb
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(Snow & Perrins 1997). Males have highly variable plumages, with various extents of yellow feathering on breast, belly and head. The plumage of females, and especially juveniles of both sexes, is less conspicuous, with mainly light grey and brown underparts, and some light yellow parts in adult females (Gutiérrez 1997).

Cirl Buntings were trapped with mist-nets at Juncosa (Lleida, northeast Spain, 41°23'N, 00°46'E) in July-August 1996 and August 1997. Individuals were ringed, wing-length and body-mass were measured, and moult stage and different plumage characteristics of the males were recorded. Blood was extracted by puncturing the brachial vein, and recovered in a heparinized capillary tube and on a microscope slide. After centrifugation of the capillary tubes, the three basic characteristics of colour, were later estimated (light, chroma and hue) of the plasma were measured using a Minolta CR200 colorimeter. The colorimeter sends a standardised light flash over the table used to score the plasma and analyses the reflected light (see Senar *et al.* 1998). Hue represents the wavelength of a colour and is measured in degrees of a circle with red at 0 degrees, yellow at 90 degrees, green at 180 degrees, blue at 270 degrees and completing the circle with red at 360 degrees. Lightness corresponds to the physical light intensity, to the colour sensation produced over a scale of greys. Lightness was measured on a sliding scale with 0 for black to 100 for white. Chroma is positively correlated to colour monochromatism (Küppers 1996), and is measured as percentage saturation ranging from 0 for white to 100 for pure colour.

Blood samples were obtained from 93 individuals (Table 1). No differences were detected in lightness and hue values of plasma between young, adult males and adult females (Kruskall-Wallis test: light, $H_{3,93} = 2.61$, $P = 0.27$; hue, $H_{3,93} = 0.03$, $P = 0.93$). Highly significant differences were found in the chroma values of plasma ($H_{3,93} = 24.02$, $P < 0.0001$). These differences were due to a higher chroma values of males compared to females (Mann-Whitney U-test, $Z_{22,9} = -2.99$, $P = 0.003$) and juveniles ($Z_{22,9} = -4.80$, $P < 0.0001$), but no differences occurred between juveniles and females ($Z_{22,9} = -0.42$, $P = 0.68$). A higher proportion of males than females were undergoing body moult (F-Fisher, $P = 0.001$). No differences were found in plasma coloration in moulting and non-moulting males (chroma: $Z_{17,5} = -1.14$, $P = 0.25$; light: $Z_{17,5} = -0.51$, $P = 0.61$; hue: $Z_{17,5} = -0.12$, $P = 0.91$). Non-moulting males showed higher chroma scores than non-moulting females ($Z_{5,8} = -2.49$, P = 0.01), although no differences were found for the other two variables (light: $Z_{5,8} = -0.44$, $P = 0.66$; hue: $Z_{5,8} = -0.44$, $P = 0.66$). Comparisons for moulting and non-moulting females, and for moulting males and females were not computed due to the small number of moulting females captured.

The basic assumption of this study is that plasma coloration reflects carotenoid content (see Brush & Johnson 1976; Brush 1990; Hill *et al.* 1994, for a discussion of its validity). On this ba-

Table 1. Aspect of plasma colour (see text) in unsexed juvenile, and adult male and female, Cirl Buntings (averages ± 1 SD).

	n	Lightness	Hue	Chroma
Juveniles	62	83.4 ± 3.9	87.7 ± 7.0	47.2 ± 6.2
Males	22	82.5 ± 3.3	87.9 ± 4.4	57.1 ± 8.2
non-moulting	5	82.7 ± 3.5	88.5 ± 5.0	61.3 ± 8.5
moulting	17	82.4 ± 3.4	87.8 ± 4.3	55.9 ± 7.9
Females	9	81.5 ± 7.3	83.5 ± 15.3	47.1 ± 8.1
non moulting	8	80.9 ± 7.5	82.2 ± 15.7	48.7 ± 7.0
moulting	1	86.1	94.3	34.4

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All inquiries about the scientific program of the 23rd congress, as well as comments and suggestions for the general program, plenary lectures, and symposia should be sent to Dr Fernando Spina, Chair, Scientific Program Committee, 23rd Congress, Instituto Nazionale per la Fauna Selvatica, Via Ca' Fornacetta 9, I-40064 Ozzano Emilia (BO), Italy, phone +39 51 65 12 111, fax +39 51 79 66 28, e-mail <infsioc@iperbole.bologna.it>.

General questions and comments should be sent to Dr Walter J. Bock, President of the 23rd Congress (address see below). Inquiries about the International Ornithological Committee should be sent to Dr Dominique G. Homberger, Secretary of the International Ornithological Committee, Department of Biological Sciences, 508 Life Sciences Building, Louisiana State University, Baton Rouge, LA 70803-1715, USA, phone +1 504 388 1747, fax +1 504 388 2597, e-mail <zodhomb@lsu.edu>. Information about the IOC can also be obtained from a new home page at <http://www.nmnh.si.edu/BIRDNET/IOC/> which is currently under construction.

Dr Walter J. Bock, President of the 23rd Congress, Department of Biological Sciences, Columbia University, 1200 Amsterdam Avenue, Mail Box 5521, New York, NY 10027-7004, USA, phone +1 212 854 4487, fax 1 212 865 8246, e-mail <wb4@columbia.edu>.

COMPLETE TABLE OF CONTENTS OF ARDEA AVAILABLE ON DISKETTE

A complete table of contents of *ARDEA* is now available on diskette (Dbase IV format), including titles of articles, short notes, notes and notices, book reviews, necrologies and introductions, 3455 titles in all: 1912-1998, vols. 1(1) to 86(1). *ARDEA* was the continuation of '*Jaarboekjes der Nederlandsche Ornithologische Vereeniging*' (Annual reports of the Netherlands Ornithologists' Organisation), which was issued between 1904 and 1911, and the table of contents of which is included on the diskette (152 titles).

The index file was issued for the first time in December 1998, and will be followed by updates, which can be ordered at any moment, convenient for the user. The diskette is issued at a price of Dfl. 50,= per copy (Dfl. 45,= for members of the NOU, institutes and libraries Dfl. 250,=). Updates are available for Dfl. 25,= (Dfl. 22,50 / Dfl. 100,=) per copy. The diskette does not include a search engine, for it is assumed that the data will be imported into reference systems of one's own choice. Besides the index of *ARDEA* and of Jaarboekjes der N.O.V., the diskette contains a complete index of:

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Vanellus (1948-1998, vol. 1-51(5); 6621 titles)
Op het Vinkentouw (1963-1998, vol. 1-87; 1311 titles)
Wiek en Sneb (1951-1956, vol. 1-4; 317 titles)
Het Vogeljaar (1957-1998, vol. 5-46(5); 9688

sis, the carotenoid content of male plasma was higher than that of females and juveniles. These differences could be related to the higher carotenoid content of male plumage, and the need for higher carotenoid levels to produce more brightly coloured plumage (Hill *et al.* 1994). That the proportion of moulting males in our sample was higher than that of females could have biased our estimates of plasma carotenoids if the ingestion of carotenoids, or the degree to which they were retained in the blood, increased during the moult (see Hill 1995b). However, there was no difference in plasma coloration between moulting and non-moulting males. Sexual differences in plasma chroma remained statistically significant when only the data from nonmoulting birds were considered. Additionally, juvenile birds that were still growing their first feathers in some parts of the body had lower carotenoid levels than males. This suggests that the patterns found are not an artifact of sexual differences in moult initiation date.

Differences in plasma coloration have been also reported in the House Finch and the Northern Cardinal (Hill 1995a). These studies suggest that there are sexual differences in the quantity of carotenoids transported in the blood. The causes of these differences are not understood, but several non-mutually exclusive hypotheses have been proposed. For example, males and females could differ in the density of carotenoid-carrying proteins in the blood (see Trams 1969). Sexual differences in foraging behaviour or diet selection could also result in a higher carotenoid intake in males (Hill 1992). Our data do not allow us to determine the reasons for this pattern, which has so far been investigated in very few species. Investigation of carotenoid levels in non-sexually dimorphic species could provide additional information. If the reported differences were really related to plumage needs and not to other ecological factors differing between sexes, we would expect to find no differences in the plasma coloration of non-dimorphic species. However, Bortolotti *et al.* (1996) have recently reported the existence of sexual differences in the concentration of plasma caretonoids in Loggerhead Shrikes *Lanius ludovicianus*, a species without carotenoid derived colorations.

Dr Juan Carlos Senar (Museu de Zoologia de Barcelona) kindly allowed us to use the colorimeter. Manel Pomarol provided essential support for the work. The Arbones family provided lodging facilities and greatly improved our foraging success. Francisco Cerdà and Montserrat Panyella collaborated in the field work. The comments of Geoff Hill, Jocelyn Hudon and Theunis Piersma inproved an earlier version of this manuscript.

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Hill G.E., R. Montgomerie, C.Y. Inouye & J. Dale

sitism, parentage, extra-pair copulations (including necrophilia), ectoparasites, predators, crèches, information centres, kleptoparasitism, and non-breeding. However, it is a book full of anecdotes rather than insightful scientific observations, a book of how a fairly self-confident academic trains and leads his rather anonymous assistants and students in the field. There is no doubt, however, that the Cliff Swallows, in their tightly packed colonies in culverts form an ideal study object and that the many years of study in Nebraska have been exceptionally productive. Good news is the fact that there is an extensive subject index in the back of this paperback, so that interesting subjects can be easily (re-)located. *(CJC)*

SECOND MEETING EUROPEAN ORNITHOLOGISTS UNION GDANSK (POLAND), 15-18 SEPTEMBER 1999

The European Ornithologists Union was established in 1997. The aim of the Union is the advancement of ornithology and the promotion of the scientific study of birds among ornithologists within Europe. The first EOU Meeting was held in Bologna, Italy. There was nearly 250 participants from 28 countries (mostly from the west part of Europe). The aim of the Second Meeting is to create an opportunity for a really large number of ornithologists from the whole of Europe to exchange the most recent results of their work in different topics, to make it possible to discuss different aspects of their research, to make contacts between central/eastern scientists and western ones as effective as possible. Thus it was agreed to hold this conference in Poland to enable many scientists to come from central and eastern part of Europe. The conference will include three days of meetings and will consist of: - plenary sessions (with invited key speakers) - symposia/workshops - poster sessions with special time for presentation and discussion. There will be post-conference excursions. The conference language will be English, and the proceedings will be published in English.

The second conference will take place in Gdansk, an old town situated on the coast of Baltic Sea in the north part of Poland. It will be held at the University of Gdansk. The venue offers good facilities for meetings, is not far from the centre of the town, easily accessible by car, tram or subway. The conference fee ($120), includes conference documents and proceedings.

Organising committee: University of Gdansk, Bird Migration Research Station, Przebendowo 84-210 Choczewo, Poland, phone +4858 676 32 20, fax +4858 676 32 65, e-mail <eou.meeting@univ.gda.pl>.

23RD INTERNATIONAL ORNITHOLOGICAL CONGRESS IN BEIJING, AUGUST 2002

At the 22nd International Ornithological Congress held in Durban, South Africa, 16-23 August 1998, the International Ornithological Committee voted to accept the invitation from the Chinese ornithologists to host the 23rd International Ornithological Congress in Beijing, China, on 11-17 August 2002. Information can be obtained via e-mail <infocenter@ioc.org.cn>, via the internet at <http://www.ioc.org.cn>, or via the home page of the 22nd congress at <http://www.ioc.org.za>.

It will be possible to register and to submit abstracts via the internet. The following are contact addresses of people responsible for the 23rd Congress in Beijing. Professor Xu Weishu, Secretary-General of the 23rd Congress, Beijing Natural History Museum, 1-1-302, Beijing Science and Technology Commission Apt., Balizhuang, Haidian District, Beijing 100037, China, phone & fax: + 86 10 6846 5605, e-mail <s-g@ioc.org.cn>. The Honorable Liu Feng, Assistant Secretary-General of the 23rd Congress, China International Conference Center for Science and Technology, Xueyuan Nan Road, Beijing 100081, China, phone + 86 10 6217 4952; fax +86 10 6218 0142, e-mail <liufeng@public.bta.net.cn>. Requests to be in-

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SAMENVATTING

Carotenen zijn plantaardige biologische kleurstoffen die meestal verantwoordelijk zijn voor de felle rode, oranje en gele kleuren van vogels. Vogels kunnen caroteen niet zelf aanmaken, en de stoffen moeten dus met het voedsel worden opgenomen. Caroteen wordt naar groeiende veren getransporteerd via de bloedbaan. In deze studie werden caroteenconcentraties in het bloed geschat aan de hand van de mate van kleuring van het bloedplasma bij de in Zuid-Europa algemeen voorkomende Cirlgors *Emberiza cirlus*. Bij deze gorzensoort heeft het mannetje een geler verenkleed dan het vrouwtje. Inderdaad was het bloedplasma van mannetjes geler dan dat van de vaal-gekleurde vrouwtjes en juvenielen. De resultaten voor de geelgekleurde Cirlgors zijn in overeenstemming met eerdere studies aan roodgekleurde zangvogels: bij dichromatische vogelsoorten wordt in het bloed van de felgekleurde sexe het meeste caroteen getransporteerd. *(TP)*

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Corresponding editor: Theunis Piersma

Browsing through this fascinating book gives the impression that most birders were bearded men. There is some exceptions, like Evelyn Baxter (1879-1959) and Leonora Rintoul (1875-1953), Emilie Snethlage (1868-1929), Elizabeth Kozlova (1892-1975) and a few other women who have a prominent place in this book. All these people are described and when possible depicted in a book that reads like a novel. This is a book about the names we so often see attached to bird names: Linnaeus, Hutton, Pleske, Temminck, Steller, MacGillivray, Bulwer, Franklin, and Gould to name a few. Chapters are devoted to the bird artists (e.g. John Gould), army officers (e.g. Richard Meinertzhagen), clergymen and missionaries (e.g. Reverend Francis Jourdain) and the professional field collecters (e.g. Alfred Russell Wallace). It describes their methods of killing, skinning and preparing, labelling and note taking, and in particular the difficulties in the field and the severe problems involved with getting the specimens home. If all went fine, there were still the museum disasters like fire or insects ruining vast collections.

The writers, Barbara and Richard Mearns, must be congratulated with their work. On the dust cover we read that "they strongly believe that the important role of the scientific collectors should not be forgotten and that their collections should not be undervalued." This book is a serious contribution towards achieving just that.

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ALSO RECEIVED

ERRITZOE J. & H.B. ERRITZOE 1998. - *Pittas of the World. A Monograph on the Pitta Family* - The Lutterworth Press, Cambridge. ISBN 0 7188 2961 1. Hardback, 207pp, 32 colour plates, some line drawings and B&W photographs, numerous maps. Price: £ 30.= (*f* 94.=).

Only two years after the publication of an identification guide on Pittas, Broadbills and Asities (Lambert & Woodcock 1996, Pica Press, Sussex), this monograph on the Pitta family has been published. After a very detailed chapter on the Pitta familiy and its place within the Passeriformes there are 30 species accounts, a key to the synonyms and new proposed names, a glossary, 5 appendices and an impressive bibliography (*ca.* 1300 references). Anyone interested in Pittas should have this book. The texts are very well organised, with clear headings and subdivisions, information on recent records (after 1975), habitat, vocalisations, food and feeding behaviour, breeding biology, moult, biometrics, and worldwide museum holdings of skins. Perhaps not expected in a book like this are sections on Pittas in captivity, which include incredible details such as the survival of individuals on a diet of Wayme dog food with vitamins and mixed with finely diced three-day-old mice, apparently because "Pittas are not birds for the beginner in aviculture." This book is a must, because if it isn't in the book, or cannot be found using the spectacular bibliography, it is either unknown or not worth being known. *(CJC)*

BROWN C.R. 1998. - *Swallow Summer* - University of Nebraska Press, Lincoln. ISBN 0-8032-6145-4. Paperback, 371pp, 26 B&W photographs, 2 maps. Price $ 16.95 (*f* 31.50).
In this book, best described as a novel in diary format, Charles Brown, one of the co-authors of *Coloniality in the Cliff Swallow* (University of Chicago Press, 1996), leads the reader through one field season, in fact the 15th consecutive season of study. The book starts on May 8, 1995 (the start of a new field season) and ends on July 27, when the expedition packs up to move home again. It describes in a rather entertaining manner the field work at colonies of Cliff Swallows *Petrochelidon pyrrhonota* near Ogallala in southwestern Nebraska, USA. Although a description of field work rather than study results, several interesting biological aspects are addressed, such as colony formation, site faithfulness, brood para-

ESSAYS ON RECENT PUBLICATIONS
(AN INVITATION)

In addition to the 'ordinary' book reviews, in 1999, *Ardea* has inaugurated a new 'book review' section called *'Essays on recent publications'*, to publish in-depth critical reviews of important books in ornithology. New ornithological books tend to receive rather cursory treatment in the book review sections of the major journals and, inspired by the extensive book reviews published by *Evolution*, *Ardea* now aims to provide opportunities for critical readers to present lasting evaluations of new publications in their field of interest and expertise.

We invite reviewers to submit essays on challenging books published in recent years. Essays should be formatted as short publications and include a title, a list of references and the name and address of the author. The title and publication details of the book under review will be given as a footnote to the essay. *Ardea* aims to publish *'Essays on recent publications'* as soon as possible after submission. Manuscripts will be reviewed by members of the editorial team, with outside help if necessary. Twenty-five reprints will be offered free of charge.

BOOK REVIEWS

Book reviews in *Ardea* are written on invitation. Books reviewed below were received from the publishers and will be kept in the library of the Netherlands Ornithologists' Union for consultation by NOU members. The reviews are meant to alert readers to new books and to give an idea whether or not the book is worth reading or purchasing. Reviews should therefore be descriptive, but also highlight both the strengths and weaknesses of the book. Reviews should be informative, interesting and pertinent. Technical information on the books under review includes publisher, ISBN number (if available), an indication of the price (£ and *f*), the number of pages, figures, tables and photographs. Prices, if not indicated by the publishers, are based on recent catalogues of major booksellers. English pounds (£) have been converted into Dutch guilders (*f*) at a rate of 1: 3.13; 1 $ = *f* 1.86, 1 DM = *f* 1.13.

BYRKJEDAL I. & D.B.A. THOMPSON 1998 - *Tundra Plovers: the Eurasian, Pacific and American Golden Plovers and Grey Plover* - T. & A.D. Poyser, London. ISBN 0-85661-109-3. Hardback, 422 pp., one colour plate, 57 black & white plates, 89 figures, and 16 tables. Price £ 27.95 (*f* 87.50).

"Most of all this is a book by and for people who love the birds and their haunts. You may have been on a large coastal mudflat, in the midst of an agricultural landscape, or even wandering across huge tundra plains close to the North Pole. It does not really matter, for so long as you have watched a tundra plover, and thought about its behaviour, ecology and appearance, you are with us." This quote from the beginning of Ingvar Byrkjedal and Des Thompson's impressive book on the four species of *Pluvialis*, the tundra plovers, is spot on. It is a deeply inspired book, the labour of love from a gifted Norwegian/Scottish duo. The book is beautiful for its many original drawings by Ingvar Byrkjedal and for its text, and it provides an incredible, worldwide, compilation of data on the birds' morphology, distribution, population sizes, breeding schedules, breeding behaviour, migration patterns and schedules and diets. Browsing the book gives one a feel for the ecological and behavioural traits that unite the tundra plovers as a genus, but also a feel for what sets each of the species apart from the others; it impresses one with the accumulated amount of knowledge on tundra plovers whilst at the same time conveying the huge gaps in our understanding of this worldwide and enigmatic group of birds.

The scene is set in the foreword by Derek Ratcliffe, the descriptions of the authors' plover-laden personal histories, a survey of the study areas, and a review of the plover and lapwing family Charadriidae. It is clear that the tundra plovers are

ership of over 50,000 skins was not unusual. William Henry Phelps (1875-1965), with help of his son Billy and his daughter in law Kathleen collected 76,000 skins, mainly from Venezuela (Colección Ornitológia Phelps in Sabena Grande). Louis Bishop of Connecticut (1865-1950) personally shot about 40% of the 53,000 skins in his collection, many of them while on vacation. Count Hans von Berlepsch from Hessen (1850-1915), a hummingbird specialist, had a collection of 55,000 skins with no fewer than 6000 of these being hummingbirds. The birds and butterflies that Walter Rothschild initially housed in his bedroom and a garden shed gradually swelled to 280,000 bird skins, 2400 mounted birds, 200,000 birds' eggs, 3400 mammals (mounts, skins and skulls), 2,250,000 lepidoptera, 300,000 beetles and other invertebrates, reptiles and fish (later leading to the establishment of Tring Museum in which to house them). There were several more of those 'very active' collectors, conveniently summarized in the chapter on 'The Great Accumulators'.

Obviously, there was not just killing for collections and this book explores the harvests of birds and their eggs in similar detail. Birds as vermin, birds being decorative and useful, birds killed for sport, birds as food. As one dramatic illustration there is this picture of the Laysan Albatrosses (p. 14), being robbed of their eggs on Laysan (Hawaiian islands) in 1906 for companies that used albumen in the manufacture of photographic paper. The birds stand around in their colony which has just been cleared of eggs. Heaps of eggs are visible, piled up in wagons and wheelbarrows, with the collectors taking a rest. Among the collectors is a small girl visible, Tillie Schlemmer. Tillie lived on the island with her father and she, despite the local population of a few millions of seabirds, demanded pets. Father introduced English rabbits, Guinea Pigs and Belgian Hares. Tillie's pets bred so profically that her father released them. Three years later, Japanese feather hunters landed (illegally) on the island and killed 200,000 seabirds, mainly albatrosses. The colonies would probably have recovered from the robbery, but the introduced herbivores, Tillie's pets, had caused ecological disaster (erosion). With the exception of Schlemmer's tobacco patch, every green leaf on the island was consumed. Incidently, the endemic Millerbirds, Laysan Honeycreepers and Laysan Rails were wiped out. This is just one 'little' drama, or rather a few incidents leading to disaster, of which this book gives so many examples.

In the appendix of this book, 69 museums are listed, housing at least 7,362,574 skins. Since 1600, 90 species and 60 subspecies of birds have vanished from the face of the earth, the vast majority of them being island endemics. Collectors are sometimes blamed for the extinction of birds, most notably so in case of the Dodo and the Great Auk. However, this was also the era where the rapidly advancing civilization transformed the world and where the loss of natural habitat brought so many species to extinction. Habitat destruction is something at which we are still very good. While we now generally find it morally wrong to harm or kill birds, we cannot stop clearing away tropical rainforests. We now try and rehabilitate the odd oiled seabird washed ashore, shocked as we are, but at the same time we fail to stop chronic oil pollution of our seas and we continue overfishing. So, before the finger is pointed to the old collectors, we should look at ourselves first and perhaps try and appreciate the knowledge these people brought forward with their work.

The importance of 'old' and 'new' bird collections is discussed in the book, as well as current methods of adding to museum bird collections (mainly 'passive' collecting). The collections are very valuable indeed. Zoologists depend on specimen collections as the basis of systems for classification. An obvious function of skin collections is their contribution to the identification process. The brilliant paintings in modern handbooks and field guides, which we tend to take for granted, are often largely based on careful studies of skins in the museum. Further reasons in the book are given as to why we should appreciate the skin collections worldwide, although some arguments are rather far fetched.

a group on their own, standing quite apart from both the *Charadrius*-plovers as the *Vanellus*-lapwings. They are unique for their northern breeding habits and it is thought that the appearance of ice ages, 2 million years ago, may have had much to do with the origins of *Pluvialis*. The early chapters contain exceedingly detailed descriptions of the plumages and moults of each of the four species (and a discourse on the recent distinction between the American and Pacific Golden Plovers *P. dominica* and *fulva*). It also contains an original cladistic analysis of the group based on plumage characteristics. There is a lot to say for the conclusion that the Grey Plover is the sister species to the golden plovers, and that the Eurasian Golden Plover is the sister species to the lesser golden plovers, but molecular data are now needed to corroborate this. The authors do not come up with a definitive statement on the existence of two distinct subspecies of Eurasian Golden Plovers (the southern *apricaria* and the northern *altifrons*). Their data for Norway show a cline in the extent of contrasting breeding plumage, and there appears to be intriguing associations between habitat characteristics, timing of snow melt and plumage traits. This is just one of the many topics that the book indentifies as being ripe for further and fruitful enquiry!

There is a big block of four chapters that review different aspects of breeding: distribution and population size, breeding schedules, and social and parental behaviour. All of the topics are based on new summaries of existing data and on unpublished observations by the authors, especially by Byrkjedal who has accumulated experience with all four plovers species in different parts of Norway, on the Yamal Peninsula in Russia and in the Canadian Arctic.

The chapter on distribution comes up with shocking conclusions about probable population sizes of each of the species. For all four species the reviews of breeding densities in combination with estimates of available habitat lead to population estimates of 1 million pairs or more, two to 10 times the currently available population size estimates. This does not necessarily mean that the populations are faring well! American Golden Plovers seem to have successfully recovered from the onslaughts of the market hunting in United States in the 19th Century, and are still seemingly increasing their range in the Canadian Arctic. Eurasian Golden Plovers continue seriously to decline in the heather moors of western Europe, but have managed to expand their range due to deforestation in the boreal forest zone, especially in Finland. The widely reported increase of Grey Plovers in western Europe (8-fold in the British Isles since the 1970s) is unlikely to be due to real population increases but, according to Byrkjedal and Thompson, must reflect distributional changes in winter. I am not so convinced that the reported disappearance of an apparent European wintering population of Pacific Golden Plovers (highly enigmatic in its own right) could have been caused by the Dutch 'wilsternetters', especially as the historical reports of this species indicate that (in congruence with their habitat choice in Asia-Pacific) they used intertidal rather than grassland areas. For this reason, they should have been relatively immune to this form of market hunting.

Then there are wonderful summaries of the breeding schedules showing the impressive longitudinal variation in plover breeding seasonality, especially for Eurasian Golden and Grey Plovers. The song flight and ground displays of the four tundra plovers are brought alive by the many drawings and schemes of aerial movements, as well as by the sonograms and their analyses; all of this being original work again!

That the authors were not afraid to work very hard on syntheses of information, comes out in the chapter on migration. Based on the data gained from 4400 museum-skins the world over, backed-up by thorough literature reviews, several diagrams are compiled to show the worldwide phenology of south- and northward migration of the four plovers. Geographical lines of similar dates of occurrence ('isophenes'), based on the median dates for clusters of museum specimens, provide an innovative way to document migratory advance in such widely ranging species. Being

interested in age-differences in migration schedules and being frustrated with the lack of ageing information in the museum records, rather than trying to borrow so many skins the authors asked for skins to be photocopied: "soon photocopied specimens piled up, and virtually all of them were sufficiently clear to enable us to age the birds confidently!". Quite striking, and not understood, differences in the autumn distribution of juveniles and adults in especially American Golden Plovers come out as a result.

After dealing with migration and nonbreeding distributions, the book is completed with reviews of foraging and food, interactions between plovers and other shorebird species, and aspects of conservation. In the latter chapter it is pointed out how little we know about population processes in any of the tundra plovers, in spite of the fact that such knowledge is apparently considered mandatory for Eurasian Golden and Grey Plovers in the context of the EC Bird Directive. Gosh, does this really mean that there are 'societal needs' for detailed studies on the demography of our tundra plovers? Let's get going!

No serious criticisms at all, then? Well, maybe a few. To do justice to the important data-compilations on distribution and breeding- and migration-phenology, there could have been greater attention to the clarity of the lay-out of the resulting maps, which could also have been printed in a bigger format. The encyclopaedic treatment of topics, and the chapter arrangements, are sometimes at odds with the development of a strong theme. For example, the chapter on the evolution of the genus *Pluvialis* would probably have seen greater development, and been more satisfying, if it had been written as the grand synthesis of the current knowledge on tundra plovers and their habitats.The separation of text+figures from the tables (after References at the end of the book) and the extensive Appendices (before References) is sometimes a little cumbersome. The Index would have been more effective if the biological subjects had been given separate entries for each of the species, rather than similar lists of topics being given for each of them. But these are really minor quibbles, and probably rather personal ones. If you love, or even just like, plovers and the habitats in which they occur, this is a book for you.

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MEARNS B. & R. MEARNS 1998. - *The Bird Collectors* - Academic Press, San Diego. ISBN 0-12-487440-1. Hardback, 472pp., many unique B&W photographs and portraits, 3 tables, 4 maps. Price: £ 29.95 (*f* 93.50)

The Bird Collectors is an amazing book. We all know that our grandfathers and great-grandfathers (but only on rare occasions our grandmothers) went birding with a gun rather than with a pair of binoculars. We all at least faintly know about the fashion demanding terns on women's hats, about the large scale egging on islands and in seabird colonies, about the last two Great Auks killed on Eldey (Iceland), and the extinction of the Dodo on Mauritius and the Passenger Pigeon in North America. But this book goes far beyond that faint knowledge and shows us in detail what is absolutely worth knowing about our orntihological history! Prism binoculars were not invented until the beginning of the 1900s and the notion that an experienced birdwatcher could confidently identify every species he saw, using binoculars and a field guide, was only slowly accepted by 'the old shotgun school of ornithologists'. The belief that "What's hit is history, what's missed is mystery" was firmly entrenched in their minds. So, the Victorian birder was working on his personal bird collection. Therefore, early bird books concentrated on the identification of birds in the hand, not in the field, depicting wing formulae, tarsi, webs and toes, beaks, and the pattern on individual feathers.

These personal collections were often huge and by the end of the nineteenth century the own-