

## The diet of the Citril Finch (*Serinus citrinella*) in the Pyrenees and the role of *Pinus* seeds as a key resource

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### Summary

The diet of the Citril Finch (*Serinus citrinella*) in its eastern range is well known, especially in spring; however, no data are available from its western populations. The aim of this paper is to provide extensive data on the diet of the species in the Pyrenees. Samples were obtained by visual inspection of the gullet of 3394 birds from 49 different localities over an area of 4000 km<sup>2</sup>. Analyses revealed a clear phenological pattern: (1) the Arvensis period, November-January, when the bird relies on farmland seeds, mainly *Chenopodium sp.* (2) the Arboreal period, February-May, when the birds focus on Pine seeds (*Pinus nigra* and *P. uncinata*); (3) the Meadow-Ruderal period, June-October, when the bird feeds on several grasses and herbs, including *Taraxacum officinalis* (mainly in June) and *Cirsium sp.* (mainly August-September). Hence the Citril finch normally specialises in a few key species, but during certain periods may opportunistically expand its dietary range. Pine seeds appear crucial, both in determining the breeding distribution of the species and in allowing opportunistic spring breeding.

**Keywords:** Citril Finch, diet, phenology, Pinus, Pyrenees.

### Zusammenfassung

#### Die Nahrung des Zitronengirlitzes (*Serinus citrinella*) in den Pyrenäen und die Rolle von *Pinus* Samen als Hauptnahrung

Die Kenntnisse zur Ernährung des Zitronengirlitzes in seinem östlichen Verbreitungsgebiet, insbesondere im Frühling, sind ziemlich vollständig. Aus den westlichen Populationen liegen jedoch keine Daten vor, trotz ihrer grundlegenden Bedeutung für das Verständnis der Dynamik und der Bewegungen von Zitronengirlitz-Populationen. Ziel dieser Arbeit ist die Darstellung von umfangreichem Datenmaterial zur Ernährung der Art in den Pyrenäen. Mit Hilfe visueller Untersuchung des Kropfes, in dem die Nahrung unverändert aufbewahrt wird, wurden in einem 4000 km<sup>2</sup> großen Gebiet Daten von 3394 Vögeln an 49 verschiedenen Stellen gesammelt. Zusätzlich wurden systematische Beobachtungen von Vögeln im Freiland (n = 510) durchgeführt, indem nahrungssuchende Vögel beobachtet und anschließend die als Futterquelle genutzten Pflanzen eingesammelt wurden. Die Auswertung erlaubte es, ein klares phänologisches Muster zur Ernährung des Zitronengirlitzes aufzustellen: (1) Die Arvensis-Periode von November bis Januar, in der die Vögel auf Samen in landwirtschaftlich genutzten Gebieten angewiesen sind, vor allem *Chenopodium sp.*, (2) Die Baum-Periode von Februar bis Mai, in der sich die Vögel auf

Kiefern Samen (*Pinus nigra* und *P. uncinata*) konzentrieren. (3) Die Wiesen-Ruderal-Periode von Juni bis Oktober, in der die Vögel verschiedene Gräser und Kräuter fressen, einschließlich *Taraxacum officinalis* (hauptsächlich Juni) und *Cirsium sp.* (hauptsächlich August-September). Der Zitronengirlitz scheint demnach eine Art zu sein, die normalerweise auf wenige Schlüsselarten spezialisiert ist und zu bestimmten Zeiten ihr Ernährungsspektrum opportunistisch erweitert (verschiedenerlei Samen von 53 verschiedenen Arten und mehr als 22 Familien); dieses Muster entspricht neuen Beschreibungen der Nahrungswahl der Art im Nordschwarzwald. Kiefern Samen erscheinen als Schlüssel-Nahrung in der Populationsdynamik des Zitronengirlitzes: die Bergkiefer bestimmt sowohl in Zentral- als auch in Südeuropa die Brutverbreitung der Art in der subalpinen Zone, und die Schwarzkiefer dürfte eine grundlegende Rolle für das Auftreten von opportunistischen Bruten spielen, die für die Populationen südwestlicher Gebiete charakteristisch sind.

### Introduction

The Citril Finch (*Serinus citrinella*) inhabits the boreal mountain zones of western temperate Europe (Cramp and Perrins, 1994), maintaining the highest densities in the Pyrenees (Baccetti and Märki, 1997). Its diet consists mainly of grass seeds and during the winter and spring the seeds of the Mountain pine (*Pinus uncinata*) are also of key importance (Cramp and Perrins, 1994; Förschler, 2001a; Förschler, 2001b; Genard and Lescourret, 1986; Glutz and Bauer, 1997; Newton, 1972). In south western Europe, however, seeds of the Black pine (*Pinus nigra*) have also been thought to predominate during winter and spring (Borras and Senar, 1991). This difference in diet between western and central/northeastern populations may influence Citril Finch dynamics, allowing for opportunistic breeding in south western areas (Borras and Senar, 1991).

Although quantitative studies of the diet in the eastern range are available (Förschler, 2000; Förschler, 2001a; Glutz and Bauer, 1997; Sabel, 1965), especially for spring, no data are available from western populations, despite the importance of these data in understanding Citril Finch population dynamics and movements. Data on wintering birds is even scarcer, and only anecdotal (Crousaz and Lebreton, 1963; Märki, 1976; Praz and Oggier, 1973).

The aim of this paper is to quantify the diet of the Citril Finches inhabiting the Pyrenees by visual inspection of the gullet, in which the food is stored unaltered. The bird's latest meal can be seen through the skin when the feathers on the neck are blown aside. This method allows an unbiased quantification of the diet by comparison to a standard seed collection, without the bird having to be killed. (Newton, 1972).

### Material and Methods

Some 8,777 Citril Finches were inspected for food from 1977 to 2000. Of these birds, 3394 contained seeds, and were thus used in analyses. Data derive from 49 different localities spread over an area of 4000 km<sup>2</sup>. Samples were obtained both from mountainous (n = 39) (300–1200 m a.s.l.) and subalpine/alpine localities (n = 10) (1200–2400 m a.s.l.). For subalpine/alpine localities we distinguished between south (n = 6) and north (n = 4) facing slopes because of the importance of this aspect for the species (Senar et al. 2002).

The different seeds observed through the skin of the gullet were classified according to size and colour into six main categories: mountain pines (*Pinus nigra* and *P. sylvestris*), subalpine pines (*Pinus uncinata*) (pine seeds distinguished *ad hoc* according to the locality where the birds were trapped), Dandelion (*Taraxacum officinalis*), Thistle (*Cirsium eriophorum*), Goosefoot (*Chenopodium album*), and miscellaneous herbs (containing all the small seeds from grasses and herbs, most of which appear in table 1). We additionally carried out systematic ob-

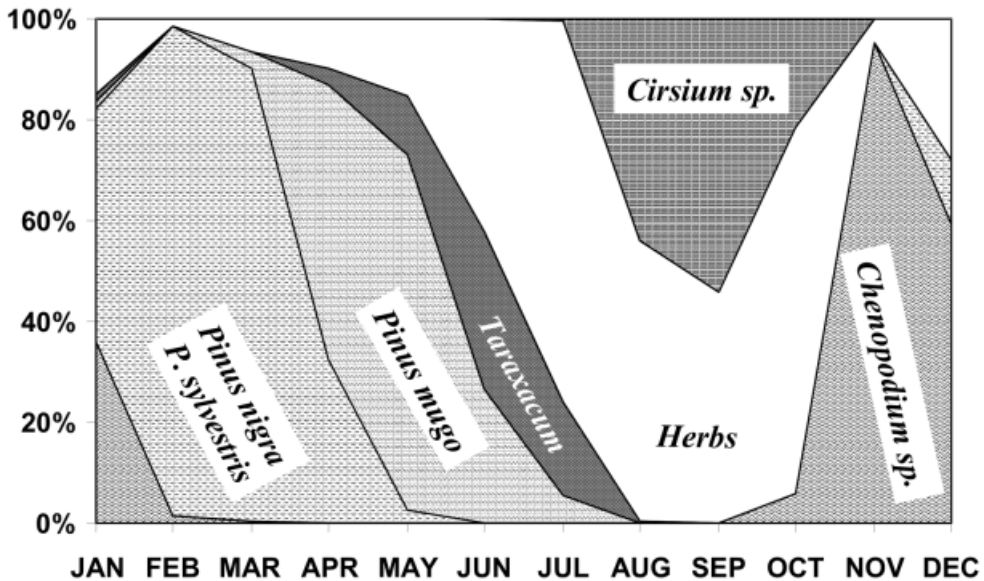


Fig. 1. Monthly phenological variation in Citril Finch diet expressed as percentage of individuals containing different kinds of seeds in their gullet (n= 3374 individual readings).

Abb. 1. Monatliche Variation verschiedener Nahrungsanteile beim Zitronengirlitz (n = 3374 Feststellungen).

servations of birds in the wild (n = 510), locating feeding birds and later collecting the plants used as a food source.

## Results

Citril Finch diet varied through the year, as indicated by the significant interaction between the different months of the year and the kind of seeds ingested by Citril Finches ( $\chi^2 = 7629.10$ ,  $df = 55$ ,  $p < 0.001$ ; Fig. 1). From February to May, birds mainly relied on pine seeds (70–99%), Black and Scots pine from January to March (mainly Black pine), the Mountain pine from April to May.

Correspondence analysis, relating the different seeds to months, revealed a clear phenological pattern in the diet of the Citril Finch (Fig. 2). The first axis explained 34% of the variance, and distinguished the period from November to April, when birds stay in moun-

tainous localities, from the period from May to October, when the birds stay in subalpine and alpine areas. The second axis, which explained another 30% of the variance, distinguished herbaceous from arboreal (i. e. pine) seeds. On the basis of this analysis, we can distinguish three main periods in Citril Finch diet (Fig. 2): (1) The Arvensis period, from November to January, when the bird relies on farmland seeds, mainly Goosefoot; (2) The Arboreal period, from February to May, when the bird focuses on Pine seeds; (3) The Meadow-Ruderal period, from June to October, when the bird feeds on several grasses and herbs (Table 1), including Dandelion (mainly in June) and Thistle (mainly August-September).

Citril Finches inhabiting north facing (hygrophilous) slopes in alpine and subalpine areas relied more on the seeds of Mountain pines and Dandelions than did birds on south facing slopes (xerophilous), which used

**Table 1.** Systematic classification of the different miscellaneous herbaceous seeds observed to be consumed by Citril Finches in the Pyrenees (we do not include *Taraxacum officinalis*, *Cirsium eryophorum* or *Chenopodium album*). The list includes 22 families and 53 species. O = occasional (less than five observations); F = frequent (five or more observations) (n = 510).

**Tab. 1.** Systematische Liste der Nahrung von Zitronengirlitzen in den Pyrenäen (ohne *Taraxacum officinalis*, *Cirsium eryophorum* und *Chenopodium album*). Die Liste enthält 53 Arten aus 22 Familien. O = gelegentlich (weniger als 5 Nachweise); F = häufig. Anzahl Proben = 510.

	Mountainous	Alpine
• Compositae 13		
<i>Carduus</i> sp.	–	O
<i>Helianthus annuus</i>		
<i>Artemisia herba-alba</i>	F	–
<i>Erigeron canadensis</i>	O	–
<i>Erigeron acer</i>	O	–
<i>Inula viscosa</i>	F	–
<i>Lactuca saligna</i>	O	–
<i>Santolina chamaesiparissus</i>	F	–
<i>Carlina vulgaris</i>	–	O
<i>Cirsium carlinifolia</i> (= <i>Cardus carlinifolia</i> )	–	F
<i>Cardus pyrenaicus</i>	–	F
<i>Cichorium intybus</i>	O	–
• Urticaceae 1		
<i>Urtica dioica</i>	–	O
• Polygonaceae 2		
<i>Polygonum aviculare</i>	O	F
<i>Rumex</i> sp.	O	–
• Chenopodiaceae 2		
<i>Chenopodium bonus-enricus</i>	–	F
• Amaranthaceae 1		
<i>Amarantus retroflexus</i>	F	–
• Caryophyllaceae 2		
<i>Cerastium fontanum</i>	–	O
<i>Stellaria media</i>	–	O
• Cruciferae 4		
<i>Sisymbrium austriacum</i>	–	O
<i>Capsella bursa-pastoris</i>	–	F
<i>Diplotaxis muralis</i>	O	–
<i>Erophila verna</i>	–	O
• Rosaceae 3		
<i>Potentilla erecta</i>	–	O
<i>Potentilla reptans</i>	O	–
<i>Alchemilla glauscescens</i>	–	O
• Leguminosae 1		
<i>Medicago rotundifolia</i>	–	O

• Linaceae	1		
	<i>Linum catharticum</i>	–	O
• Cistaceae	1		
	<i>Helianthemum oleandicum</i>	–	O
• Umbelliferae	1		
	<i>Bupleurum ranunculoides</i>	–	O
• Verbenaceae	1		
	<i>Verbena officinalis</i>	F	–
• Labiatae	5		
	<i>Thymus serpyllus</i>	–	F
	<i>Teucrium pyrenaicum</i>	–	O
	<i>Satureja montana</i>	F	–
	<i>Lavandula latifolia</i>	O	–
	<i>Lavandula angustifolia</i>	–	O
• Scrophulariaceae	2		
	<i>Verbascum sp.</i>	–	O
	<i>Linaria supina</i>	O	–
• Globulariaceae	1		
	<i>Globularia repens</i>	–	O
• Plantaginaceae	2		
	<i>Plantago lanceolata</i>	O	–
	<i>Plantago media</i>	–	O
• Dipsacaceae	1		
	<i>Scabiosa columbaria</i>	O	–
• Liliaceae	1		
	<i>Ornithogalum umbellatum</i>	–	F
• Juncaceae	1		
	<i>Luzula campestris</i>	–	O
• Gramineae	6		
	<i>Setaria viridis</i>	O	–
	<i>Deschampsia flexuosa</i>	–	O
	<i>Festuca scoparia</i>	–	O
	<i>Briza media</i>	–	O
	<i>Poa annua</i>	–	O
	<i>Poa pratensis</i>	–	O
• Cyperaceae	1		
	<i>Carex montana</i>	–	O

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**Table 2.** Number of Citril Finches carrying different kinds of seed in their crop according to whether they were trapped on south-facing (n = 6) or north-facing (n = 4) Pyrenean slopes (total n = 2698 crop readings). Expected frequencies in brackets.

**Tab. 2.** Zusammenhang zwischen Anzahl Zitronengirlitze mit Nahrung im Kropf und Hangexposition (Südhänge: n = 6; Nordhänge: n = 4; Anzahl Proben = 2698). Erwartungswerte in Klammern

Slope	<i>Pinus uncinata</i>	<i>Taraxacum sp.</i>	Herbs	<i>Cirsium sp.</i>
South-facing	145 (201)	87 (99)	315 (272)	80 (55)
North-facing	720 (664)	339 (327)	857 (900)	155 (180)

**Table 3.** Number of Citril Finches with congealed latex on their beak according to the kind of seeds in their crop (Total n = 1441 readings, from May to July). Expected frequencies in brackets.

**Tab. 3.** Anzahl Vögel mit verharteten Schnäbeln in Abhängigkeit von der Nahrung (Anzahl Proben = 1441 zwischen Mai und Juli). Erwartungswerte in Klammern.

Latex	<i>Pinus uncinata</i>	<i>Taraxacum sp.</i>	Herbs
Present	49 (162)	174 (64)	164 (162)
Absent	553 (440)	63 (173)	438 (440)

Thistle and miscellaneous seeds more often than can be attributed to chance (Contingency table  $\chi^2 = 46.30$ , df = 3,  $p < 0.001$ , Table 2).

During June, birds with traces of congealed latex on their beaks carried Dandelion seeds in their crop significantly more often than pine and miscellaneous seeds (Table 3).

**Discussion**

The Citril Finch is generally considered in Central Europe to be a non-specialised granivorous bird which feeds opportunistically on a large variety of plant species, with a preference for grass *Gramineae* seeds (Cramp and Perrins, 1994; Glutz and Bauer, 1997; Märki, 1976; Newton, 1972), although in certain periods (e.g. in winter) it may rely on only a few seed species (Glutz and Bauer, 1997). Recent data from the Black Forest, however, suggest the reverse, in that the species normally specialises on a few key species (*Pinus uncinata*, *Teucrium scorodonia*, *Taraxacum officinale*, *Rumex acetosa*, *Anthoxanthum odoratum*), and that during certain periods it may opportunistically expand its range (Förschler, 2000;

Förschler, 2001a; Förschler, 2001b). Our data from the Pyrenees agrees with this view.

In the Pyrenees, the species relies from February to May mainly on pine seeds as a main source of food (70–100 %): from January to April on Black pine (mainly) and Scots pine, when the species inhabits mountainous areas (400–1400 m a.s.l.), and on Mountain pine from May to June, when the species occupies subalpine areas (1700–2200 m a.s.l.). In the Black Forest the Citril Finch’s diet in the breeding areas (900–1100 m a.s.l.) consists from December to June of the seeds of Mountain pine, which become the main food source (70–90 % of observations) in April-May (Förschler, 2000; Förschler, 2001a). Under bad weather conditions, Citril Finches in the Black Forest move to lower altitudes (500–800 m a.s.l.), mostly relying on the seeds of Wood sage (*Teucrium scorodonia*) (Förschler, 2000; Förschler, 2001b). In the Pyrenees during mild winter periods with no snow, the species may stay in the subalpine breeding areas, feeding on Mountain pine, but usually the species inhabits the mountainous areas at lower altitudes,

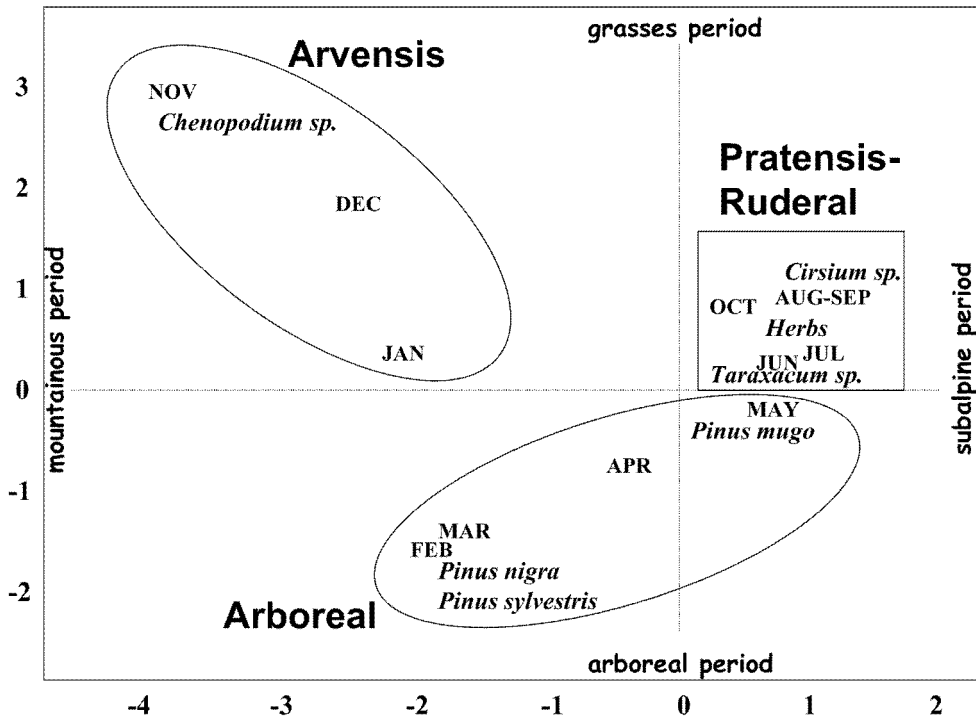


Fig. 2. Plot of the first two components from a Correspondence Analysis relating the different months of the year to the main seeds found in Citril Finch crops.

Abb. 2. Korrespondenzanalyse zum Zusammenhang zwischen Jahreszeit und Nahrung beim Zitronengirlitz

where it feeds mainly on the Black pine and to lesser extent on the Scots pine.

The Mountain pine is therefore a key food source for the Citril Finch in both the Pyrenees and the Black Forest (Borras, 1983; Borras and Junyent, 1993; Förschler, 2000; Förschler, 2001a). Other Central European conifers, such as Norway Spruce (*Picea abies*) and European Silver-fir (*Abies alba*), cannot be used as a main food source because seeds fall in winter when snow cover is still too heavy for Citril Finches to use the subalpine areas (Marki, pers. comm.). This may be part of the reason why some general publications underestimate the use of coniferous seeds by the species (Cramp and Perrins, 1994; Newton, 1972). The extensive range of Black pine and to a les-

ser extent of Scots pine in the Pyrenean areas, as indeed also in the southern systems such as the Iberic, Central and Pennibetic, also play a key role in the ecology of Citril Finches, providing not only snow-free refuges during winter, but also a highly proteinaceous resource allowing for the opportunistic breeding of the species in early spring (February-March) (Borras and Senar, 1991; Garcia Rua, 1974). The extent of this opportunistic behaviour depends on the productivity of Black pine, which fluctuates greatly from year to year (Borras et al. 1996). This behaviour has not previously been described for transpyrenean populations.

During June in the Pyrenees, the species relies mostly on dandelion (30%) and on miscellaneous subalpine grasses (40%). This is the

period when grasses (e.g.: *Festuca sp.*, *Poa sp.*, *Briza sp.*, *Capsella bursa-pastoris*) are used most, and when birds quite often (27 %) have congealed latex on their beaks, which comes from Dandelion (Campbell, 1980). The use of pine and dandelion seeds is more pronounced on north facing slopes. Occasionally, during April and May, dandelion located at lower altitudes is used as an alternative food source during late snow storms by those birds already inhabiting subalpine areas. Herbs and grasses (e.g., *Chenopodium bonus-enricus*, *Polygonum aviculare*, *Thymus sp.*, *Poa sp.*) are the main food source during July and August, when the species moves to alpine meadows and can take a wider variety of food. Thistle and similar Compositae (*Cirsium*, *Cardus*) make up most of the diet during autumn, mainly associated with human-modified areas. This dietary sequence from the Pyrenees closely resembles the general pattern described for populations north of the Pyrenees (Förschler, 2000; Förschler, 2001a; Glutz and Bauer, 1997).

During winter, the diet consists mainly of Goosefoot and other ruderal plants (*Rumex sp.*, *Polygonum avicularia*, *Amaranthus retroflexus*), and of Compositae (*Inula viscosa*, *Santolina chamaesiparissus*, *Artemisia herba-alba*), as could be expected from studies in Central Europe (Crousaz and Lebreton, 1963; Märki, 1976; Praz and Oggier, 1973).

The Citril Finch therefore specialises for most of the year on a few key species, e.g. Mountain Pine from April to May (this work, Förschler 2001a), Dandelion during June (this work, Förschler 2001a), Alpine Lady's-mantle (*Alchemilla conjuncta*) in the Jura mountains during August-September (Marki pers. com.), Goosefoot in winter (this work), alternating with periods when it takes a wider range of items. Labiatae and Vervencaceae species, which contain relatively large quantities of essential oils, and which are not often consumed by cardueline finches (Newton, 1972), are comparatively abundant in the diet of wintering Citril Finches; these observations have

been obtained from monospecific Citril Finch flocks, whereas many of the observations of the species feeding on other families of plants have been recorded from mixed species flocks. These aromatic herbs are also used to a lesser extent during the reproductive period in subalpine areas (*Thymus serpyllus*, *Teucrium pyrenaicum*, *Lavandula angustifolia*). Similarly, some plants of this group (e.g. *Teucrium scorodonia*) are also important to the diet of the species in Central Europe (Förschler, 2000; Förschler, 2001a; Glutz and Bauer, 1997). This may allow wintering Citril Finches to use marginal biotopes on slopes and burrs and partially to outcompete other cardueline species.

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### References

- Baccetti, N. & Märki, H. (1997): Citril Finch. In: Hagemeyer, W.J.M. & Blair, M.J. (eds.): The EBCC atlas of European breeding birds: 711–711. London.
- Borras, A. (1983): Lluçaret, *Serinus citrinella*. In: Muntaner, J., Ferrer, X. & Martínez-Vilalta, A. (eds.): Atlas dels ocells nidificants de Catalunya i Andorra: 273–274., Barcelona.
- Borras, A., Cabrera, A. & Cabrera, J. (1996): Cross-bills *Loxia curvirostra* feeding on cypress seeds. Butll. GCA 13: 53–55.
- Borras, A. & Junyent, F. (1993): Vertebrats de la Catalunya central. Edicions Intercomarcals. Barcelona.



- Borras, A. & Senar, J. C. (1991): Opportunistic breeding of the Citril Finch *Serinus citrinella*. *J. Ornithol.* 132: 285–289.
- Campbell, W. D. (1980): Cause of death of Goldfinches. *Brit. Birds* 73: 479–480.
- Cramp, S. & Perrins, C. M. (1994): *The birds of the Western Palearctic* Vol. VIII. Oxford.
- Crousaz, G. & Lebreton, P. (1963): Notes sur la migration du Venturon montagnard (*Carduelis citrinella*) aux cols de Cou-Bretolet, et sur son hivernage en Suisse et en France. *Nos Oiseaux* 27: 46–61.
- Förschler, M. (2000): Untersuchungen zur Brutphänologie, Nahrungswahl und Habitatwahl des Zitronengirlitz (*Serinus citrinella*) im Nordschwarzwald. Diploma Thesis, Fakultät für Biologie der Eberhard-Karls-Universität Tübingen.
- Förschler, M. (2001a): Brutzeitliche Nahrungswahl des Zitronengirlitzes *Serinus citrinella* im Nordschwarzwald. *Vogelwelt* 122: 265–272.
- Förschler, M. (2001b): Witterungsbedingte Ausweichbewegungen des Zitronengirlitzes *Serinus citrinella* im Nordschwarzwald. *Orn. Beob.* 98: 135–140.
- García Rúa, A. E. (1974): Primera reproducción comprobada de *Carduelis spinus* en el Centro de España y nuevos datos de cria de *Carduelis citrinella*. *Ardeola* 20: 382–384.
- Genard, M. & Lescourret, F. (1986): Abondance et répartition des petits vertébrés consommateurs de graines de pin à crochets (*Pinus uncinata* Miller ex Mirbel) en forêt d'Osséja (Pyrénées Orientales). *Vie Milieu* 36: 27–36.
- Glutz, U. N. & Bauer, K. M. (1997): *Handbuch der Vögel Mitteleuropas*. Wiesbaden.
- Märki, H. (1976): Brutverbreitung und Winterquartier des Zitronenzeisigs *Serinus citrinella* nördlich der Pyrenäen. *Orn. Beob.* 73: 67–88.
- Newton, I. (1972): *Finches*. Collins, London.
- Praz, J. C. & Oggier, P. A. (1973): Sur l'hivernage du Venturon montagnard *Serinus citrinella* en Valais. *Nos Oiseaux* 32: 109–112.
- Sabel, K. (1965): Beobachtungen an Zitronengirlitzen und anderen Finken im Schwarzwald. *Gef. Welt* 89: 32–51.
- Senar, J. C., Conroy, M. J. & Borras, A. (2002): Asymmetric exchange between populations differing in habitat quality: a metapopulation study on the Citril Finch. *J. appl. Stat.* 29: 425–441.

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