IDENTIFICATION KEY OF IBERIAN WADERS (CHARADRIIFORMES) BASED ON THE *OS QUADRATUM*

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Identification key of Iberian waders (Charadriiformes) based on the os quadratum.– Two hundred and fifty seven skulls belonging to 28 wader species from several osteological collections were analysed to elaborate an identification key based on the *os quadratum*. The presente/absence of *foramen processi otici*, presence/absence of *foramen processi orbitale*, number of *processus orbitalis foranina*, profile of the *processus orbitalis* and condylar formula has been used. This key identifies 75% of the species concerned at specific level.

Key words: Iberian waders, Identification key, *Os quadratum*.

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INTRODUCTION

The assignation of the bony fossils or actual remains to a specific or generic name is difficult due to the lack of identification works (MORENO, 1985). It is necessary the use of a comparison collection, this method being less rigorous than the use of an identification key.

Several authors have elaborated osteological keys on the basis of the whole skeleton or the skull (CUISIN, 1981, 1982, 1983; MORENO, 1985, 1986, 1987; SELSTAM & SELSTAM, 1973). Nevertheless, comprehensive descriptions of most skeletal structures of avian orders are needed, as they allow the identification at species or genus level.

The morphology of the *os quadratum* (fig. 1) differs among species (WALKER, 1888). SHUFELDT (1903) and BOCK (1960) give a brief description on the morphology of the quadrate of several Charadriiform species. It is an outstanding role on the avian classifications (DERSELBE, 1926; LOWE, 1926) and appears frequently in the bird fossils deposits (see LAMBRECHT, 1933; ARREDONDO, 1976; GINGERICH, 1976; MARTIN & RATE, 1976; LUCAS, 1983). Moreover, the *os quadratum* plays a very important role in the movements of both the upper and the lower mandible by means of the articulation with the lower jaw, the braincase, the pterygoid bones and the jugal bars. The muscles involved in the movements of the mandibles also have attachment on this bone (ZUSI, 1967; BÜHLER, 1981). Therefore, the quadrate has a great importance in the feeding apparatus as an essential feature of the kinetic mechanism of birds due to its movable character (BURTON, 1974). It also has the function to support the mandible totally or partly against forces that could disarticulate it (BOCK, 1960; BURTON, 1984). More details about the role of the quadrate can be found in ZUSI (1959) and BOCK (1964).

This paper deals with the study of the morphology of this bone and presents an identification key for the iberian species of Charadriiformes. This avian order of the Charadriiformes is represented on the Mid-

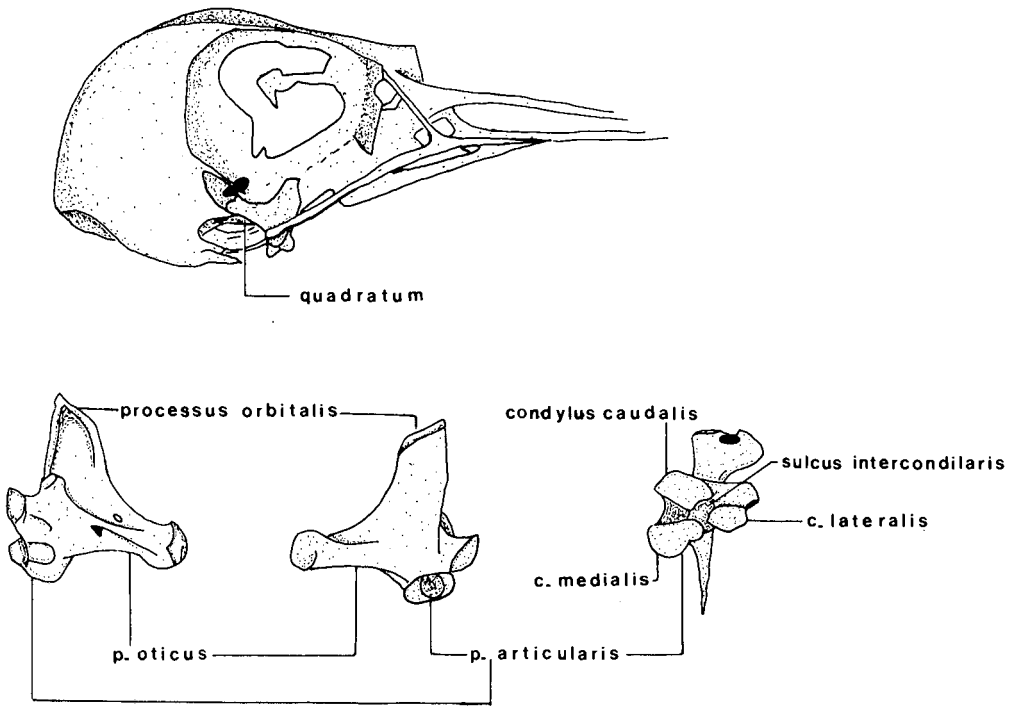

Fig. 1. *Os quadratum* position in the skull of a Charadriiform bird and its anatomy.
Anatomía del hueso cuadrado y posición en el cráneo de un charadriforme.

dle Tertiary by six of the present families (CAROLL, 1988) and they often appear in fossil deposits (see BALLMAN, 1979; BICKART, 1982) or in pellets of several raptors (VALVERDE, 1967).

MATERIAL AND METHODS

The *os quadratum* of 257 skulls including most of the Iberian Charadriiformes from several osteological collections (Cátedra de Vertebrados – Facultad de Biología, Universidad Complutense de Madrid, Museo Nacional de Ciencias Naturales – CSIC, Instituto de Estudios Avanzados de Baleares – CSIC, British Museum of Natural History) were studied. The species studied and the number of individuals are: *Haematopus ostralegus* (11), *Himantopus himantopus* (4), *Recurvirostra avosetta* (7), *Burhinus oedicnemus* (11), *Glareola pratincola* (6), *Charadrius hiaticula* (9), *Ch. alexandrinus* (3), *Pluvialis squatarola* (8), *Vanellus vanellus* (24), *Calidris alba* (5), *C. ferruginea* (5), *C. alpina* (28), *C. canutus* (14), *Philomachus pugnax* (16), *Gallinago gallinago* (16), *Lymnocryptes minimus* (4), *Scolopax rusticola* (12), *Limosa limosa* (9), *L. lapponica* (6), *Numenius arquata* (16), *N. phaeopus* (4), *Tringa erythropus* (2), *T. totanus* (12), *T. nebularia* (3), *T. ochropus* (9), *T. glareola* (1), *Actitis hypoleucos* (5), *Arenaria interpres* (7).

The nomenclature follows BAUMEL et al. (1979).

To elaborate the key the following characters were used (fig. 2):

a) presence/absence of *foramen processi otici;*
b) presence/absence of *foramen processi orbitale;*
c) number of *processus orbitale foramina;*
d) profile of the *processus orbitalis;*

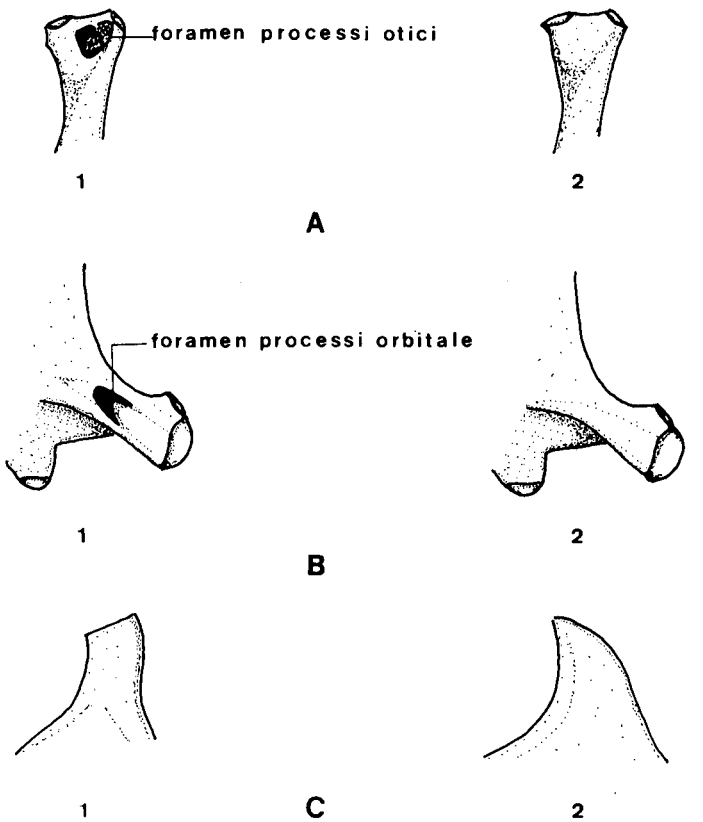

Fig. 2. Characters used to elaborate the identification key: A1. *Foramen processi otici* present; A2. *Foramen processi otici* absent; B1. *Foramen processi orbitale* present; B2. *Foramen processi orbitale* absent; C1 and C2. *Processus orbitalis* profiles.

Caracteres utilizados en la elaboración de la clave: A1. Foramen processi otici *presente; A2.* Foramen processi otici *ausente; B1.* Foramen processi orbitale *presente; B2.* Foramen processi orbitale *ausente; C1 y C2. Perfiles del* processus orbitalis.

c) condylar formula. The condylar formula is defined by the relative development of the condylar surface of the *processus articularis* and it is expressed like e.g. A>B=C, where A is the *condylus lateralis* surface, B the *condylus caudalis* surface and C the *condylus medialis* surface (fig. 3).

RESULTS

The new key has been useful to identify at specific level 75% of the species concerned. The reamining 25% have been identified but there are no differences between two or three species (e.g. *Tringa totanus* and *Philomachus pugnax; Calidris alba, Charadrius hiaticula* and *Actitis hypoleucos; Vanellus vanellus* and

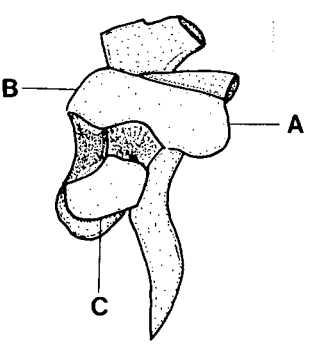

Fig. 3. Position of the *processus articularis cotyla:* A. *Condylus lateralis;* B. *Condylus caudalis;* C. *Condylus medialis.*

Posición de los cóndilos del processus articularis cotyla: *A.* Condylus lateralis; *B.* Condylus caudalis; *C.* Condylus medialis.

Charadrius alexandrinus). The presence/absence of *foramen processi otici* have an intraspecific variation of 12% in *Gallinago gallinago* and the number of *processus orbitale foramina* have an intraspecific variation of 11% in *Charadrius hiaticula*.

Identification key

1. *Foramen processi otici* present (fig. 2A1) 2
– *Foramen processi otici* absent (fig. 2A2) 10
2. *Foramen processi orbitale* present (fig. 2B1) .. 3
– *Foramen processi orbitale* absent (fig. 2B2) . 13
3. *Processus orbitalis* having only one foramen .. 4
– *Processus orbitalis* having two foramina 7
4. Profile of the *processus orbitalis* as in figure 2C1 5
– Profile of the *processus orbitalis* as in figure 2C2 6
5. Condylar formula: B=C>A ... *Limosa limosa*
– Condylar formula: C>B>A ..... *Limosa lapponica*
– Condylar formula: A>B=C ..... *Tringa totanus*, *Philomachus pugnax*
– Condylar formula: A>C>B ..... *Glareola pratincola*
6. Condylar formula: A=B>C ..... *Calidris minuta*
– Condylar formula: A>B=C ... *Calidris alpina*
7. Profile of the *processus orbitalis* as in figure 2C1 8
– Profile of the *processus orbitalis* as in figure 2C2 9
8. Condylar formula: A>B>C .... *Tringa ochropus*
– Condylar formula: B=C>A .. *Arenaria interpres*
– Condylar formula: A>B=C ..... *Calidris alba*, *Charadrius hiaticula*, *Actitis hypoleucos*
9. Condylar formula: A=B=C .. *Calidris canutus*, *Calidris ferruginea*
– Condylar formula: A>B=C ... *Tringa glareola*
10. *Foramen processi otici* present (fig. 2B1) 11
– *Foramen processi otici* absent (fig. 2B2) ..... *Gallinago gallinago*
11. *Processus orbitalis* having only one foramen ... 12
– *Processus orbitalis* having two foramina ..... *Tringa nebularia*
12. Condylar formula: B>A>C ..... *Numenius phaeopus*
– Condylar formula: A>C>B ..... *Pluvialis squatarola*
– Condylar formula: C>A>B ..... *Recurvirostra avosetta*
– Condylar formula: A=B>C . *Numenius arquata*
– Condylar formula: A>B=C ..... *Tringa erythropus*
13. Profile of the *processus orbitalis* as shown in figure 2C1 14
– Profile of the *processus orbitalis* as shown in figure 2C2 15
14. Condylar formula: C>A>B ..... *Himantopus himantopus*
– Condylar formula: A>C>B ..... *Burhinus oedicnemus*
– Condylar formula: A>B=C .... *Vanellus vanellus*, *Charadrius alexandrinus*
15. Condylar formula: A>B=C ..... *Lymnocryptes minimus*
– Condylar formula: C>B>A ..... *Scolopax rusticola*
– Condylar formula: A>C>B ..... *Haematopus ostralegus*

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RESUMEN

Clave de identificación de los Charadriiformes ibéricos basada en el hueso cuadrado.

Se ha elaborado una clave osteológica basada en la morfología del hueso cuadrado para la identificación de Charadriiformes ibéricos. Para ello, se han utilizado 257 cráneos pertenecientes a 28 especies de limícolas, procedentes de diversas colecciones osteológicas. En la elaboración de la clave se han tenido en cuenta la presencia/ausencia del *foramen processi otici*, la presencia/ausencia del *foramen processi orbitale*, el número de forámenes del *processus orbitalis*, la forma del perfil del *processus orbitalis* y la fórmula condilar. Esta clave identifica a nivel específico el 75% de las especies estudiadas.

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