

Assessing the age of the Red-crested Pochard ducklings *Netta rufina* (Anatidae, Anseriformes) based on photo comparisons

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Abstract

The assessment of the size of the Red-crested Pochard ducklings *Netta rufina* in the wild was undertaken in the Hassar Dam on two late broods, one recently hatched and the second slightly older and was used to test the validity of the proposed model. This evaluation is done by comparing all chicks to the size of the mother (on several photographs). The use of the evolution of the measurements (body size, head size and bill size) in relation to the mother's size based on the photographs allowed the development of a model that helps to determine the age of the ducklings in the wild in comparison to the mother's size. This model of the evolution of the ducklings' growth was verified on the second brood and allowed to determine, within a few days, the age of the ducklings.

1. Introduction

The Red-crested Pochard *Netta rufina* [Fig. 1] is distributed from Western Europe and Morocco to China and Mongolia. The species is considered of 'Least Concern' at the global level [1].



Figure 1. Pair of Red-crested Pochard *Netta rufina* in the Casablanca-Settat region (left) and a male in flight (right)

In Morocco, the Red-crested Pochard is a bird of patrimonial interest with a conservation status of 'Vulnerable' [2]. The country hosts a few dozen breeding pairs and a few hundred birds in the wintering period [3][4][5][6]. The phenological status of this species is RB (Resident breeder), WV (Winter Visitor) [7][8][9]. The Red-crested Pochard breeds in the Douyiet area [10], in Smir lagoon [11][12], in Merja Fouarate [13], in Sidi boughaba lake [4][6][14], the Lower Loukkos wetlands [15][16] which form the oldest breeding site, but from the early 1990s, the species also bred in Douyiet since 1993, in Merja Bargha from 1995 to 2000, in Sidi Bou Ghaba since 1997 and in Merja Zerga since 1999 [17], at Dar Bouazza near Casablanca, in the Oued El Maleh wetlands and Oued Hassar (Mohammedia region) [18][19] and the Moulouya estuary since 2017 (*Com. Pero.*).

In Algeria, a single breeding case of Red-crested Pochard (a single pair) was reported in the area of Dayet El-Ferd, commune of El Aricha, south of Tlemcen city [20]. This site is considered the only wintering and breeding site for the Red-crested Pochard in Algeria. In Tunisia, no breeding cases have been reported.

Age assessment of chicks in the wild is not currently practiced. The study of the age of chicks has been studied in the mallard [21] and in the common Merganser (*Mergus merganser*) [22] in breeding farms with very well fed chicks and in better conditions than in the wild.

We note the importance of Weller's studies on the development of Redheads *Aythya americana* and the comparison between the development of wild and farmed birds [23].

Our study aims to evaluate in a relative way the age of Red-crested Pochard chicks, in the wild, based on the approximate comparison of the size of the duckling to the size of the adult and proposing some variables that allow this evaluation. In 2015, in the Hassar Dam reservoir, entire Red-crested Pochard broods were monitored for more than 3 months in order to assess the age of the chicks. This study will allow the age of the broods to be evaluated on the field without resorting to capturing measurements.

2. Material and Methods

2.1. Study area

To our knowledge, the Red-crested Pochard *Netta rufina* breeds at two sites in the Mohammedia region: the Mohammedia wetlands and Hassar Dam [18][19]. The wetlands at the first site have been dry since 2012. For the Hassar site, the reproduction of this duck continued in 2015.

The dam's reservoir is located between 33°33'00,82" and 33°34'28,90"N and 7°25'27,27" and 7°26'04,54"W, in the Mohammedia prefecture region, in an area straddling the two rural communes Echellalate and Sidi Hajjaj [Fig.2].

This small reservoir discharges its water through a valve into a pipe built along Oued Hassar to the waterfall, whose water flows into Oued El Maleh. This water is used for the irrigation of vegetable crops.

Table 1 and **Figure 3** summarize the characteristics of this reservoir.

During the study period, vegetation was sparse along the lake shore, especially on the right bank. On the left bank, a few groves of *Acacia horrida* persist near an old submerged farmhouse and a belt of *Juncus acutus* heavily browsed by cattle. The recent installation of the lake has not yet allowed the installation of characteristic vegetation, except for a few *Tamarix gallica* that persist with the strong grazing of the livestock, scattered patches of reeds *Phragmites australis*, belts of tall yellow Dock *Rumex crispus*, widgeon Grass *Ruppia maritima*, common Water-crowfoot *Ranunculus aquatilis* and water silk *Spirogyra sp.* These latter aquatic plants are used by waterfowl to build their nests, especially the great crested grebe *Podiceps cristatus*, the common Coot *Fulica atra* and the Little Grebe *Tachybaptus ruficollis* [Fig. 4].

Table 1. Data sheet of Hassar Dam

Name of the dam	:	Hassar Dam
Name of the Oued	:	Oued Hassar
Date of realization	:	2004-2005
Date of the first impoundment	:	March 2005
Province	:	Prefecture of Mohammedia
Municipality/commune	:	Commune of Chellalate and commune of Sidi Hajjaj
The length of the dam	:	160 m at the crest
Total length of the dam	:	3.3 km to the ridge
Maximum width of the reservoir	:	350 m
Capacity	:	2.13 Million m ³
Catchment area	:	30.8 km ²
Destination	:	IR-Cas-Pl-Pi-AC *

* IR: Irrigation, Cas: Waterfall feeding, Pl: Pleasure, Pi: Flood protection, AC: Livestock watering..

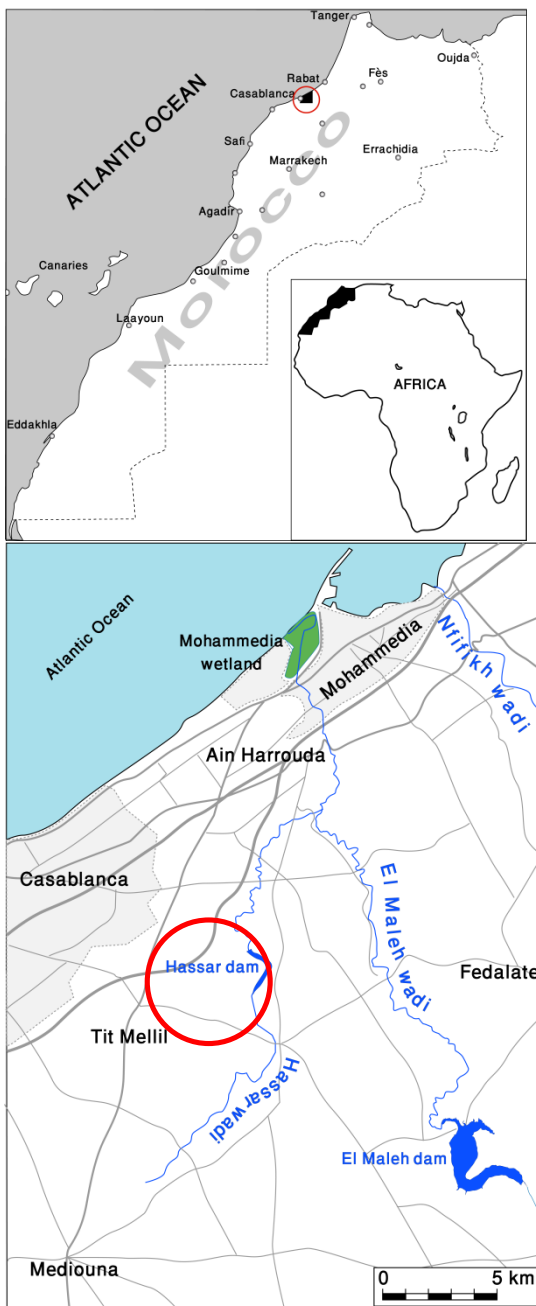


Figure 2. Location maps of the study area near Mohammedia

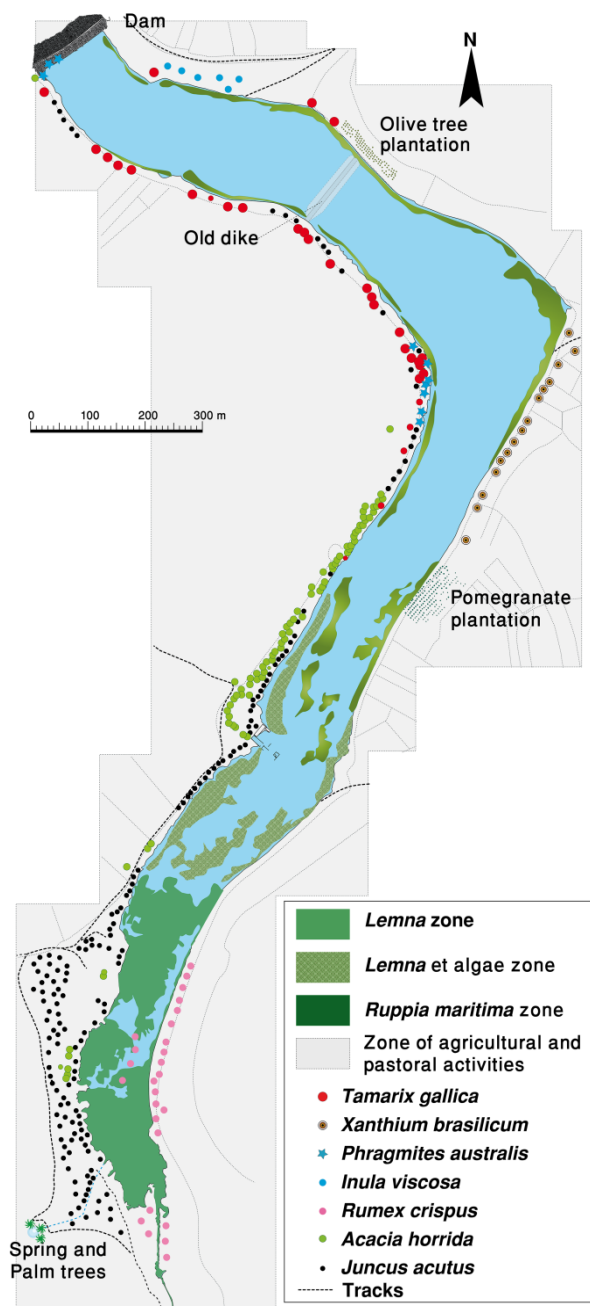


Figure 3. Dimensions and characteristics of the Hassar Dam during the study period (2015)



Figure 4. Reed bed and grass mat south of Hassar reservoir on 23/5/2015.

The southern part of the reservoir provided very good breeding conditions for a large number of bird species such as Red-crested Pochard, Ferruginous Duck, Mallard, Little Grebe, Great Crested Grebe, Common Moorhen, Common Coot, Red-knobbed Coot, Black-winged Stilt, Little Ringed Plover, Collared Pratincole, Little Tern, Common Gull-billed Tern, Kingfisher and probably Whiskered Tern [24].

During rainy years, the level of the reservoir reaches its maximum [Fig. 5] and the islets are submerged. A beautiful reed bed develops in the southern part of the reservoir, providing a shelter for several species, which can even reproduce there.



Figure 5. Evolution of the water level in the southern part of the reservoir during the same period for 4 years.

The filling of the reservoir was in this year (2015) at its maximum especially as the islets that are always emerged remained immersed for a long time. Habitat fragmentation and permanent water level variations have a negative impact on Red-crested Pochard nesting densities [25].

The diet of the Red-crested Pochard consists almost exclusively of plant constituents [26][27][28][29]. This diet is largely dominated by seeds, Potameae and Characeae. These types of plants are present in our study site, namely filamentous algae (*Spirogura sp.*), *Chara vulgaris*, *Ruppia maritima*, *Najas marina*, *Ceratophyllum demersum*, *Ranunculus aquatilis*. The Characeae plants are cited as a very important part of the diet of Red-crested Pochard [30][31]. Animal prey is scarce in the diet of this duck species [27][29][30].

2.2. Materials and methods

From June 2015, we had the opportunity to follow two recent broods with a time lag of about a week to 10 days, the first one consisting of a female with 15 chicks (the largest ever recorded) and the second observed and followed from the first or second day with 11 chicks. Other broods were observed in this reservoir all of whose juveniles were able to fly: 2 broods with 3 juveniles each, a brood with 6 juveniles and a brood with 10 adult-sized juveniles but still with their mother.



Figure 6. a- brood of 15 Red-crested Pochard ducklings at Hassar dam on 19/6/2015 (the largest brood ever recorded), b- nest of 11 newly hatched Red-crested Pochard ducklings at Hassar dam on 19/6/2015

The 11 ducklings of the second brood were photographed (with an SLR camera and a 100-400 mm zoom lens) at each monitoring trip (4 to 10 days apart, depending on the very disturbed weather conditions this year). We tried to photograph the whole family at the right angle to our position and in normal swimming (no disturbance) [Fig. 7]. The large number of photos taken allowed us to choose the right positions.

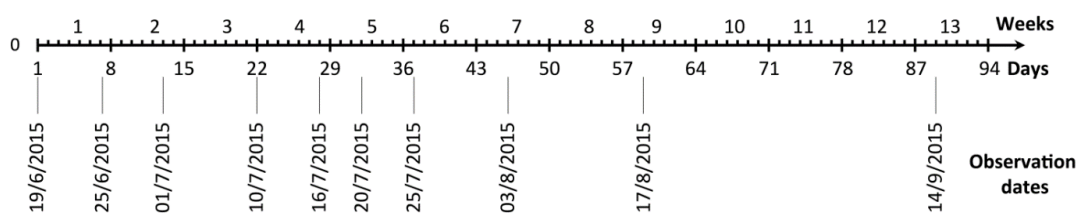


Figure 7. Chronology of duckling observations in Hassar Reservoir

The ducklings are drawn from photos taken in the field to evaluate their relative sizes and compare them to the size of the mother duck. This method was used by some authors [21][22], except that these authors used a life-size silhouette of the adult instead of a live adult [Fig. 8]. It should be noted, however, that the apparent relative size of the ducklings varies according to their behavior (disturbance, movement, feeding, resting, etc.), and the large number of photos taken of the same brood, with the same focal length of the lens used and the same position of the birds, makes it possible to select the ducklings to be redrawn on several images. The margin of error is then compensated by the presence of several ducklings in each brood.

Newly hatched ducklings of the Red-crested Pochard are almost the same size as the ducklings of the Mallard [Fig. 9] with a few small details that help to differentiate them: Bill color, habit color and cheek pattern. The color of the bill changes rapidly from pink to grey.

The methodology used for the evaluation of the age of the ducklings is based on the comparison between the duckling and the adult of:

- size ;
- length of the bill ;
- length of the head
- color.

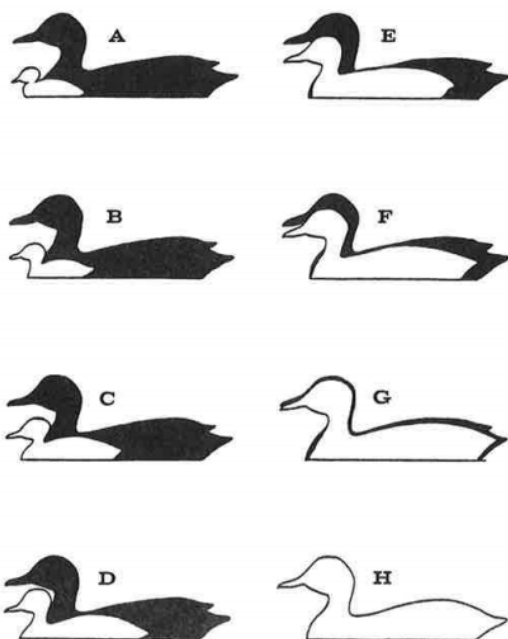


Figure 8. Comparative size of mallard ducklings silhouettes [21]

- A : 4 days old
- B : 1 week -3/8 of the size
- C : 2 weeks -1/2 of the size
- D : 3 weeks -5/8 of the size
- E : 4 weeks -3/4 of the size
- F : 5 weeks - 7/8 of the size
- G : 6 weeks - almost adult
- H : 7 weeks - adult



Figure 9. Drawings of very young ducklings of the Red-crested Pochard (left) and Mallard (right).
(A. RIHANE Drawings)

The dimensions considered in this work are summarized in **Figure 10**, which represents a female duck and her ,recently hatched, chick. Approximate measurements are based on the head length of two adult female Red-crested Pochard preserved (one in skin and the other in mounted skin) at the Scientific Institute in Rabat, Morocco. The skull size of the Red-crested Pochard at <https://skullsite.com> also shows 96 mm.

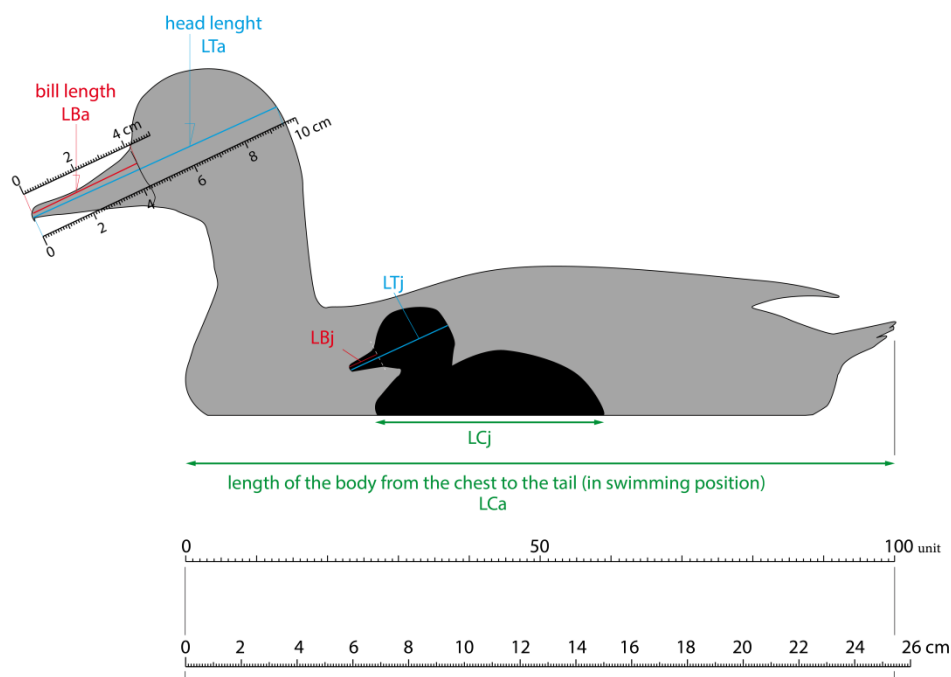


Figure 10. Dimensions considered in this study: (a-adult, j- juvenile)

The length from the tip of the bill to the occiput in both cases is 9,5 cm. This measurement is used in several adult photos which allowed us to estimate the body size of the female while swimming at about 25.4 cm (chest to tail) while the total length of the animal is given in **Table 2**.

Table 2. Adult size of Red-crested Pochard according to several authors

Length=size (cm)	Wingspan (cm)	References
56	--	[32]
56	--	[33]
53-57	85-90	[34]
53-57	84-88	[35]
53-57	84-88	[36]
♂ 57 ; ♀ 51	--	[37][38]
50	--	[39]

To facilitate the calculation of ratios and to evaluate the relative size of ducklings, the units used are arbitrary with 100 units corresponding to the length of the adult duck in water from breast to tail tip. The evolution of the duckling's growth is made according to the calculation of the following ratios:

$$R_{TB} = \frac{LBj}{LBa}, \quad R_{TT} = \frac{LTj}{LTa}, \quad R_{TC} = \frac{LCj}{LCa}$$

R_{TB} : ratio of juvenile bill size to adult bill size;

R_{TT} : ratio of juvenile head size (bill-crane) to adult head size (bill-crane);

R_{TC} : ratio of juvenile body size to adult body size.

These ratios allow comparing the growth of the different parts of the ducklings (bill, head, body...).

3. Results

Table 3 and **Figure 11** represent the evolution of length, bill and colors of the 11 Red-crested Pochard ducklings at Hassar Dam from 19/6/2015 to 14/9/2015 (approximately 3 months of monitoring). The 15-chick brood that is about a week to 10 days ahead in age is also monitored for comparison and testing the validity of the measurements and calculated ratios. From September onwards, the juveniles, which become sub-adults, are no longer with their mother but form small groups of a few individuals and have remained for a long time faithful to their preferred area (near the old ruined farm). At the end of September, these sub-adults are dispersed and cannot be attributed to a particular brood.

Table 3. Chronology of the evolution of the length and plumage of the Red-crested Pochard ducklings

	Size	Body color	Cheek color	Chick aspect/female	Bill
16/9/2015	3/10	Dark brown	Yellow	Contrast	Large pink part
25/6/2015	2/5	Brown	Light yellow	Contrast	Pink end
01/7/2015	1/2	Brown	Light yellow	Contrast	Grey
10/7/2015	3/5	brown	Light yellow		grey
16/7/2015	3/4	Brown back	Pale (adult appearance)		grey
20/7/2015	9/10 ~ 7/8	Light brown back	Head of an adult	Resemblance	grey
25/7/2015	9,5/10	Adult colors	Adult colors	Resemblance	grey
03/8/2015	1	Adult colors	Adult colors	Resemblance	Grey with pink end
14/8/2015	1,05*	Adult colors	Adult colors	Resemblance	red (♂), gray (♀)
14/9/2015	1 (adult size)	Adult colors	Adult colors (not nuptial)	Resemblance	

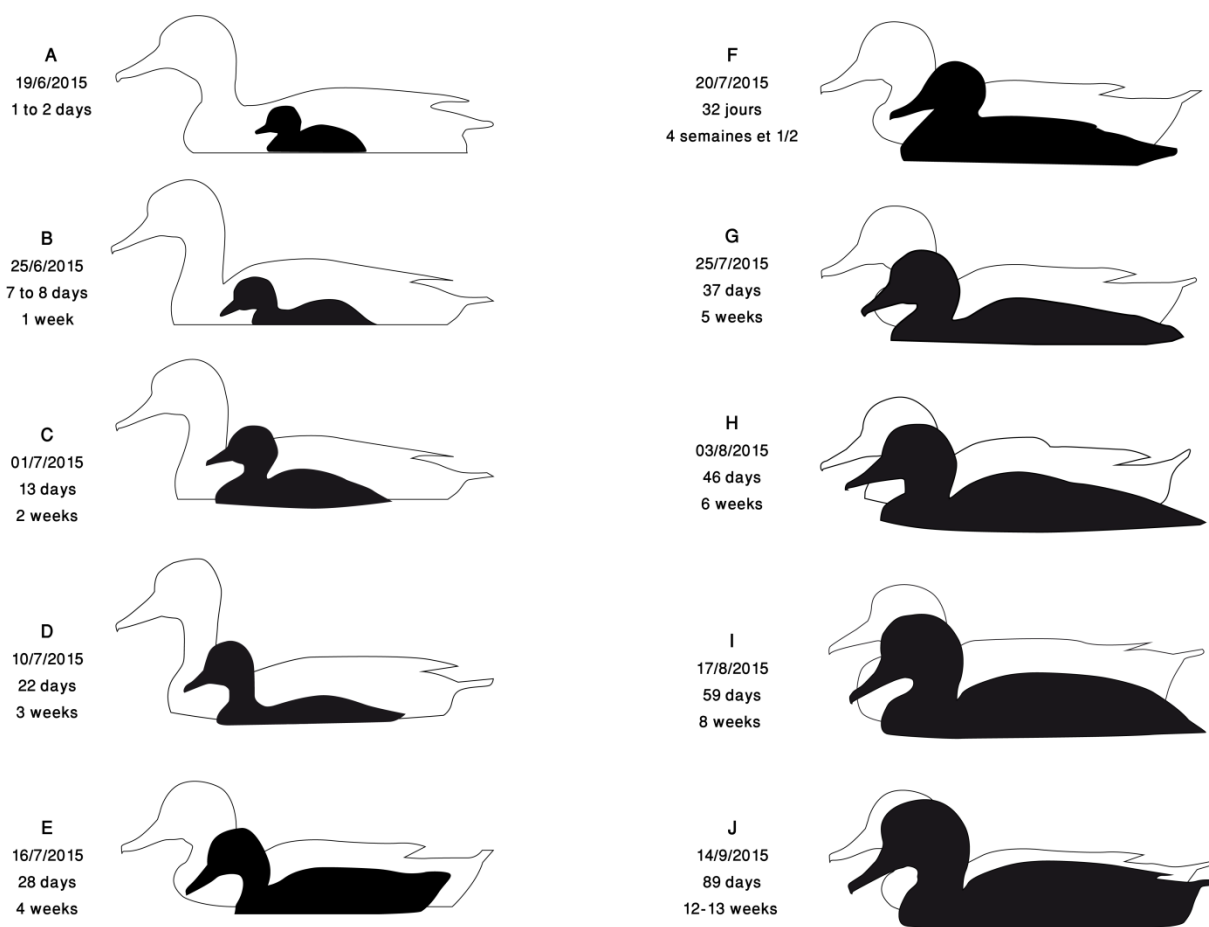


Figure 11. Chronology of the evolution of the size of the Red-crested Pochard ducklings (Drawings A. RIHANE). (Measurements are made directly on photos)

The calculation of the relative size is based on the projection of the duckling image on the mother duck image and then evaluated as a fraction. The validity of this method is evaluated by calculating the averages. The juveniles still hold their tails down which resulted in sizes sometimes larger than the adult. From the 7th week on, sub-adults behave like adults with their tails up. The measurement data of the Red-crested Pochard ducklings that will be used for the different calculations are summarized in **Table 4**.

Table 4. Evolution of the growth of the sizes of the Red-crested Pochard ducklings' parts

Date	days	Number of ducklings	Average measurements (units)		
			body	head	bill
19/06/2015	1	11	27,50	12,73	4,45
25/06/2015	7	11	44,82	14,64	5,64
01/07/2015	13	11	52,64	19,09	7,95
10/07/2015	22	11	65,27	23,14	8,86
16/07/2015	28	11	81,73	25,23	10,09
20/07/2015	32	10	85,77	27,36	11,86
25/07/2015	37	10	92,40	29,75	12,90
03/08/2015	46	10	94,90	32,20	13,40
14/08/2015	59	10	100,00	34,00	14,50
14/09/2015	89	10	100,00	35,00	15,00

The growth of the ducklings' body evolves in an almost linear way until the 6th week and then inflects and reaches the size of the adult female at the 8th week [Fig. 12]. It is worth noting, however, that some male juvenile (bill turns reddish) sometimes exceed the size of juvenile females. In other cases, some of these ducklings show smaller sizes.

The growth of the ducklings' heads evolves in an almost linear way to reach the size of the adult female at the end of the 8th week [Fig. 13]. However, this growth is slower than the growth of the body size. The growth of the bill also evolves in the same way as the head.

To compare the growth of the different body parts, we used data from the first 6 weeks before the growth curves began to sag. During this period of development, growth is almost linear [Fig. 14]. Between the 7th and 8th week the curves bend rapidly and the duckling acquires an adult size and appearance (of the female). The young males that begin to mount a reddish bill have a head color and shape that resembles the female. In this case of development in nature, the growth of the size of the duckling grows in the same way as the bill and the head. This measurement evolves in an almost linear way to reach the size of the adult female during the 7th week.

A statistical comparison of the biometric data of the ducklings (averages of size growth) in relation to the females of the Red-crested Pochard has allowed us to draw up a graph allowing the relative evaluation of the age of the ducklings [Fig. 15].

The comparative statistical study of the ratios of the growth averages of the three selected criteria (body, head and bill) shows reliability and evolution in the same way [Fig. 16]. It should be noted, however, that it is difficult to apply the criterion "bill size" in the wild, given their small size, especially during the first weeks of the ducklings' age. On the other hand, the Red-crested Pochards do not show any particularity in the color of their plumage while the male keeps the red color of his bill but looks very much like the female. The ducklings acquire very early similar appearances to the female (plumage and bill color).

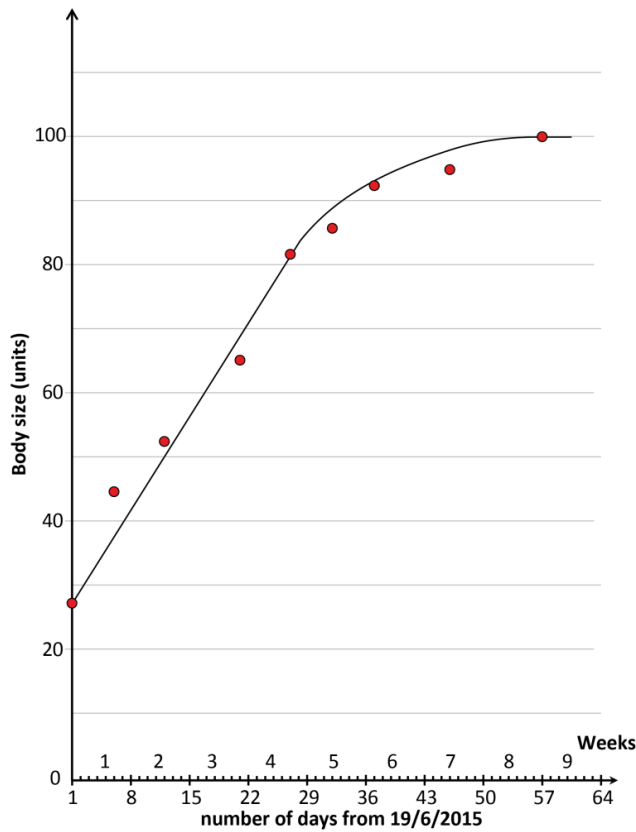


Figure 12. Evolution of Red-crested Pochard duckling size.

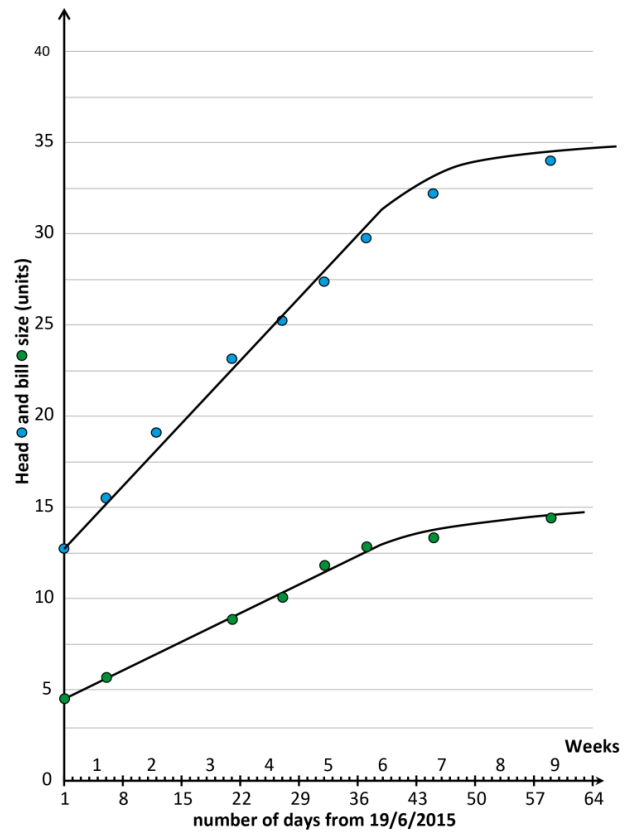


Figure 13. Evolution of head and bill length of Red-crested Pochard ducklings.

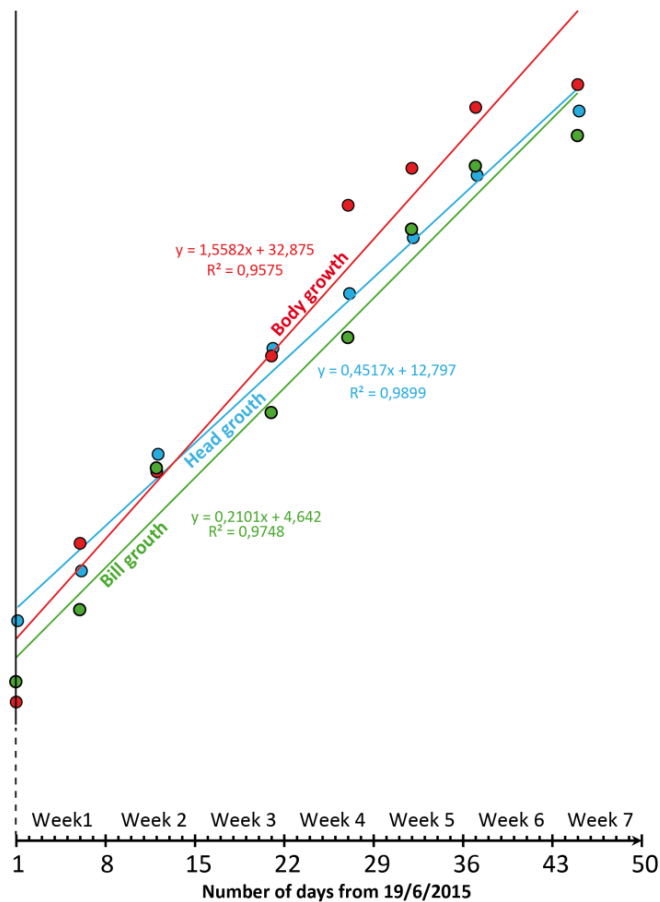


Figure 14. Comparison of the evolution of ducklings' growth during the first weeks of age

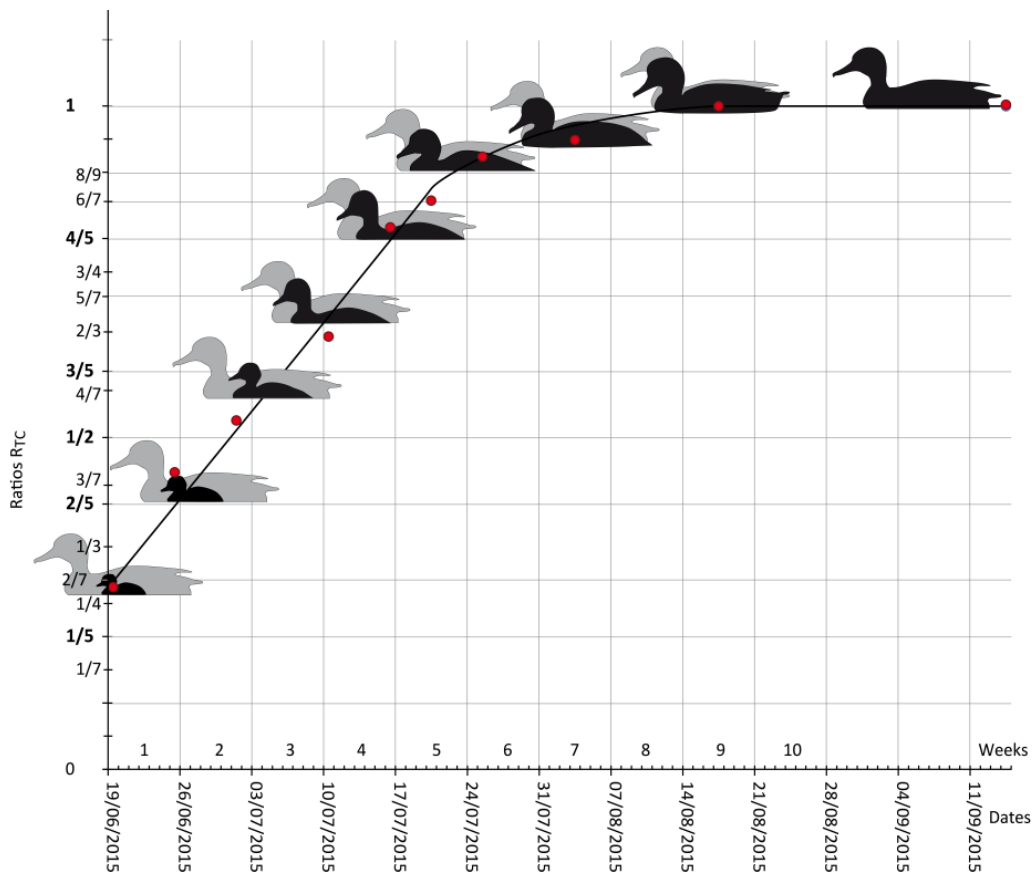


Figure 15. Age assessment of Red-crested Pochard ducklings using the R_{TC} ratio.

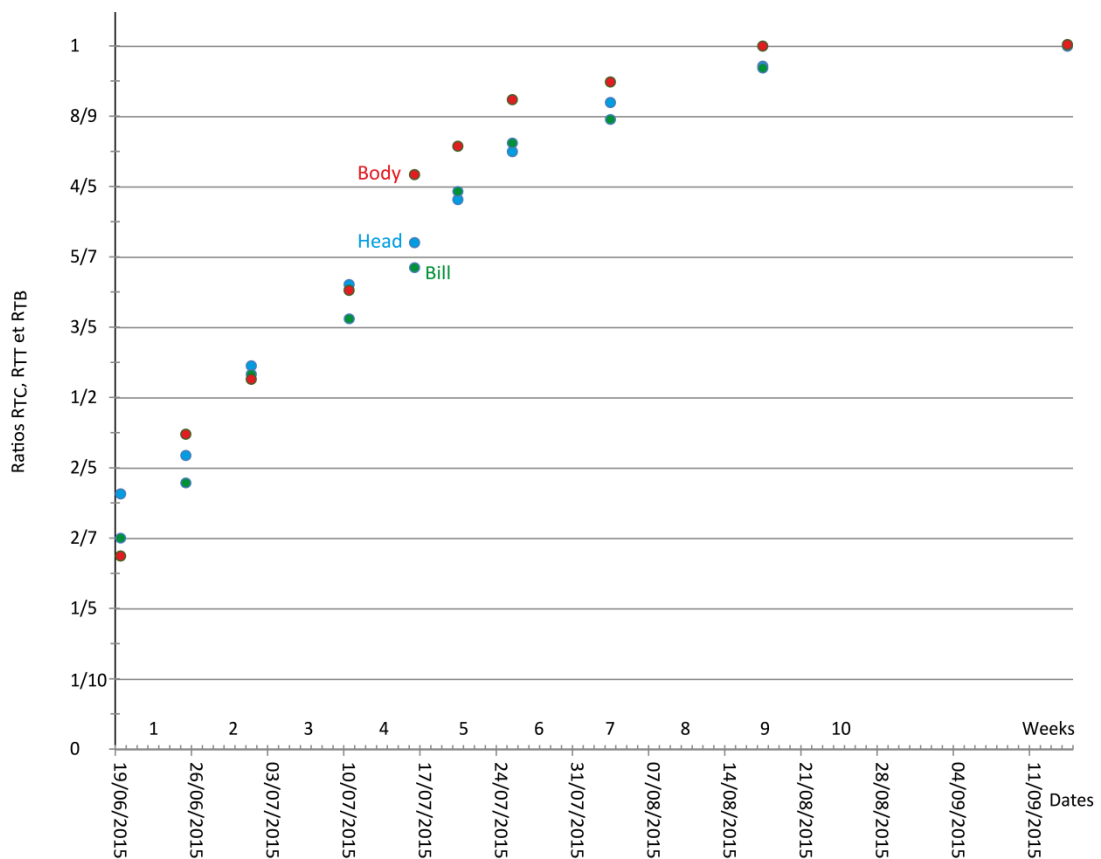


Figure 16. Evaluation de l'âge des canetons de la Nette rousse en utilisant le rapport R_{TC} , R_{TT} et R_{TB}

4. Validity test

To validate this model for estimating the age of Red-crested Pochard ducklings, it was tested on the brood discovered on 13/6/2015 that was ahead in the age of the brood studied. For this, the multiple chick size ratio (R_{TC}) was calculated for the following dates:

- On 19/6/2015, the R_{TC} showed 3/7 which brings this brood closer to 8 days old. Back-calculation gives a probable hatch on 11/6/2015;
- on 10/7/2015, the R_{TC} posted 5/6 which brings this brood closer to 28 days old. Back-calculation gives a probable hatch on 12/6/2015;
- on 20/7/2015, the R_{TC} posted just over 9/10 which brings this brood closer to 37 days of age. Back-calculation gives a probable hatch on 13/6/2015.

This calculation determined the time of the hatch of this brood probably between 11 and 13/6/2015.

5. Discussion

The Hassar Dam is very important in hosting a breeding population of the Red-crested Pochard *Netta rufina* by offering all the necessary conditions for its breeding. The wetlands in Morocco offer a highly diverse flora, which shows a great plant richness of these Mediterranean ecosystems, estimated at more than 670 species and subspecies [40]. This vegetation is very important and sometimes exclusive in the diet of several species of Anatidae [28][29]. The Red-crested Pochard has an exclusively herbivorous diet. It is undoubtedly considered the most specialized species because it is particularly attached to Characeae meadows [30][31][41]. The Hassar dam provides a foraging habitat consistent with the diet of the Red-crested Pochard especially *Chara vulgarsi* and other species such as *Ceratophyllum demersum*, *Najas marina*, *Ruppia maritima*, *Scirpus maritimus*... the activity and feeding behavior of adults and chicks of this species has been studied in France [42]. Although the literature is very poor on the breeding of the Red-crested Pochard worldwide, incubation lasts approximately 26 to 28 days [32][38]. For instance, the breeding success rate of Red-crested Pochard is given in Ile de France [42]. These authors suggest very low breeding success rates (hatching and fledging) (hatching success. 4.7 to 6.1 ducklings were produced at hatching while 1.7 to 4.4 young reached fledging/female depending on the year).

In the case of Hassar dam, 6 broods are observed in 2015 of which 4 are early with 22 juveniles fledged in late June and two late broods of 11 and 15 ducklings of which 25 have reached fledging and the brood of 11 ducklings lost 1 between 16 and 20/7/2015. In this period raptors and other predators were very numerous including Bonelli's Eagle, Peregrine Falcon, Eleonora's Falcon, Eurasian Sparrowhawk and Yellow-legged Gull. The latter species was observed preying on Mallard chicks. However, the monitored 15-brood ducklings is the largest Red-crested Pochard brood ever recorded with a 100% fledging success rate. Assessment of duckling age through field observation has been facilitated by studies on Mallard ducklings [21], Goosander ducklings [22], and Redheads [23]. By monitoring a recently hatched brood for 3 months, a scale was developed to assess the age of ducklings in the field by comparison with the mother duck and by using ratios of juvenile to adult female measurements. The results obtained are in agreement with those of these authors. The models of farmed birds proposed by several authors such as [43] are not applicable to wild birds due to the different living conditions of the two groups. Wild birds feed on what is available in their environment under changing climatic conditions as well as predation and other sources of disturbances.

6. Conclusion

The present study reports data that can be used in the relative age determination of Red-crested Pochard ducklings by assessing body size in a swimming position, head, and bill relative to those of the adult female they accompany.

This method is based on the biometry of the body parts of 11 recently hatched ducklings (reference brood) and followed throughout the study period (3 months). This method was tested on another brood, which consisted of 15 chicks that were older than the first. At the beginning of the study, the age of this brood was estimated to be 10 days ahead of the first brood, whereas it was approximately 11 to 13 days ahead of the first brood using the RTC, RTT and RTB ratio graphs of the reference brood.

The data used in this evaluation method are extracted from samples living in the wild and under ecological conditions subject to various abiotic (especially climate) and biotic (competition, predation, disturbance, etc.) factors, based on long observations and photographs. This could be substantial for better management of waterfowl. In fact, the correct field identification by hunters of target and non-target species would have significant implications for the conservation of globally threatened ducks and those protected by Moroccan hunting law. The red-crested Pochard is definitively one of those.

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