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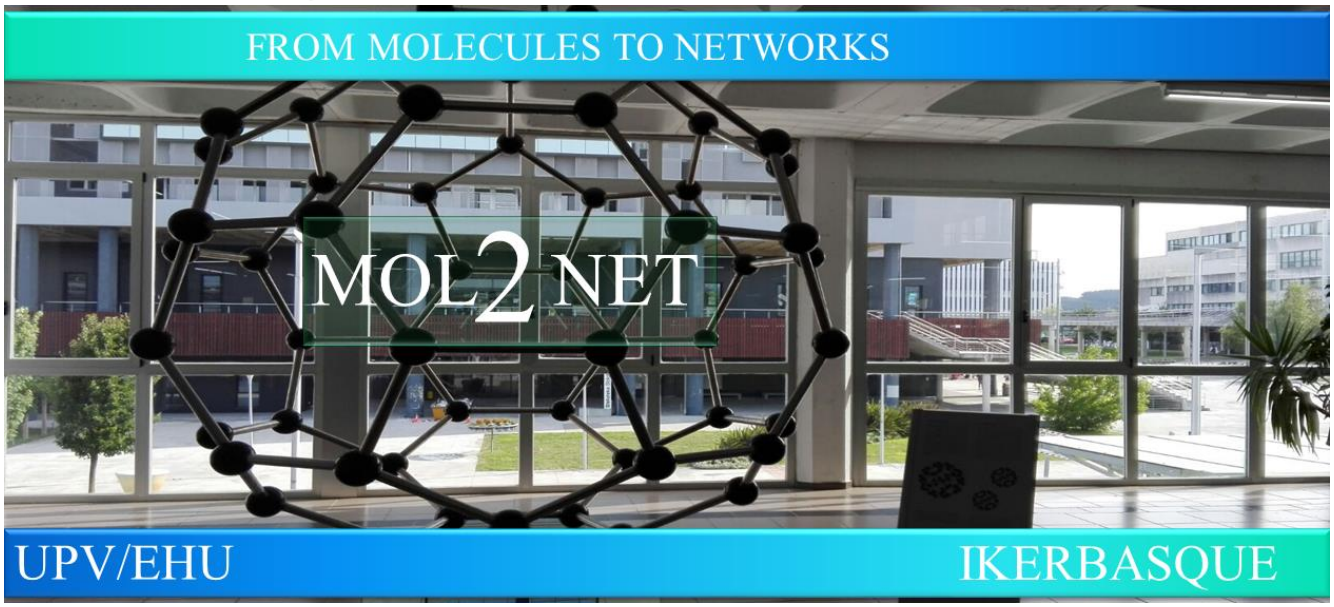

Ecological characteristics of the reproduction of the nyroca duck (*Aythya nyroca*) breeding in lake Tonga (Northeast of Algeria)

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Graphical Abstract

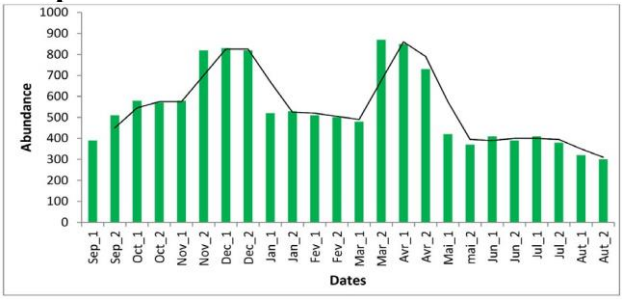

Fig. 1. Trends of the numbers of the Ferruginous Duck *Aythya nyroca* in Lake Tonga (September 2016 - August 2017)

Abstract.

The habitats and ecosystems of the Mediterranean Sea are of prime strategic interest both ecologically and economically. The Ferruginous duck, a species widely distributed in Africa, Europe and Asia, these numbers have experienced declines and changes in distribution in recent decades. The primary reasons for these declines are mainly due to habitat degradation and loss and hunting for local consumption .

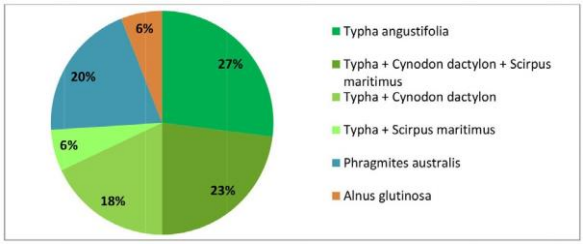

Fig. 2. Main plant supports for the nesting of the Ferruginous Duck *Aythya nyroca*.

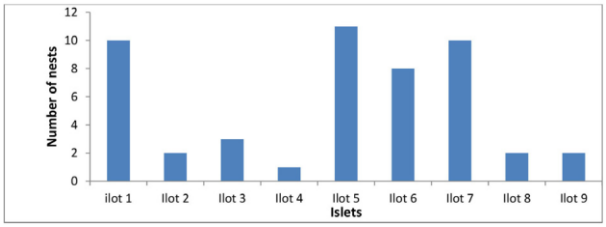

Fig. 3. Distribution of the Ferruginous Duck *Aythya nyroca* nests per islets.

Our study was carried out on the Ferruginous Duck (*Aythya nyroca*) in Lake Tonga (El Kala National Park), during the period from September 2020 to August 2021. This duck classified as a near threatened species (IUCN, Red list 2022), a regular breeder in this body of water.

We observed the evolution of the numbers of this species during the wintering season, the maximum of 830 of which was noted during the month of December. This Anatidae also prefers to install its nests on islands of *Typha angustifolia* with a rate of 64%.

It appears that the date of the beginning of the laying is estimated towards the end of April, the nests contain on average 10 to 12 eggs with a maximum of 23 eggs. The monitoring of biometric parameters exposes us to very variable measurements, i.e., an external diameter of 25.8cm [18-35.5], an internal diameter of 16.46cm [12.5-22], a depth of 9.44cm [4.5-17], an elevation of the nests compared to the water around 11.75cm [4-20] and an average inter-nest distance of 5cm [1.75-22.84].

Introduction *(optional)*

Wetlands in the northeastern region of Algeria regularly support many water bird species. Some are protected by national and international laws, such as the White-headed Duck *Oxyura leucocephala*, Purple swamphen *Porphyrio porphyrio*, the Marbled Teal *Marmaronetta angustirostris* and the Ferruginous duck *Aythya nyroca*. All these species have a breeding status as sedentary birds (Aberkane et *al.*, 2013, 2014; Chettibi *et al.*, 2013; 2014; Bara et *al.*, 2014).

The Ferruginous duck (Güldenstädt, 1770) is a diving duck of the Anatidae family classified as a Near threatened species (IUCN Redlist 2022). It is also a species protected internationally by the Bern Convention and nationally by Decree No. 83-509 of 20 August 1983 (Houhamdi and Samraoui, 2008; Aissaoui et al., 2011; Petkov and Kutsarov, 2007; Robinson and Hughes, 2003a,b; Datta, 2014). Its wintering and breeding area is extensive, covering a large part of Central, Eastern and Southern Europe, North Africa, the Middle East, Central and South Asia. Generally, the world population is estimated at 180000-249999 individuals, including 2400 to 2600 in North Africa (Birdlife International, 2015). It has suffered a massive decline over the past two decades due to several factors, mainly anthropogenic, including hunting and the destruction of its habitats and wetlands (Callaghan, 1997, 1999).

In this work, we describe the evolution of the numbers of the Ferruginous Duck *Aythya nyroca* over an entire annual cycle (2020-2021) in the main body of water in extreme northeast Algeria, Lake Tonga, in order to update its phenological status. In this contribution, we also present a diagnosis of bird nesting during the 2021 season in the various eco- logical habitats. We also present the characteristics of nests (measurements, design and construction) and eggs of this species as well as the size of egg laying, which represent the main aspects of reproductive biology.

Materials and Methods *(optional)*

The *Aythya nyroca* is a very abundant diving duck in Lake Tonga (Aissaoui *et al*., 2009, 2011; Lazli *et al*., 2011a). Its phenology was monitored over an entire annual cycle, from September 2020 to August 2021, with one outing every two weeks. The counts were carried out using a 20×60 DIGITAL-OPTIQUE telescope from different observation points to cover the entire water body. Two methods are applied, an individual count when the group of birds is small, does not exceed 200 individuals and is less than 200 meters away) or by visual estimation in the opposite case (Lamotte and Bourliere, 1969; Blondel, 1975; Legendre and Legendre, 1979; Tamisier and Dehorter, 1999). The margin of error of this method is estimated among professionals between 05 and 10% (Houhamdi, 2002; Seddik *et al.*, 2010, 2012; Boudraa *et al*., 2014). This Method Is The Most Commonly Used In Water bird Censuses (Aissaoui *et al*., 2011; Houhamdi and Samraoui, 2001, 2002, 2003, 2008; Seddik *et al.*, 2010; Metallaoui and Houhamdi, 2008, 2010; Metallaoui *et al*., 2009; Bensaci *et al*., 2011).

During the breeding period, one to two trips per week were made to monitor breeding, nest building and nest design. The parameters monitored are the depth, internal and external diameters of the nests, its height in relation to the water level of the lake, the depth of the water, the nature of the plant support used, the distances in relation to the nearest nest and in relation to the banks, the degree of visibility of the nests as well as the usual biometry of the eggs (Kouidri *et al*., 2012; Bensouilah *et al*., 2014, 2016; Zeraoula *et al*., 2015; Brahmia *et al.*, 2015; Kafi *et al*., 2015).

Results and Discussion

The Ferruginous Duck is a sedentary breeding species in Lake Tonga. It is present in all readings from the first to the last output (Fig. 1). The graph shows a breeding sedentary population of about 150-200 pairs (300 to 400 individuals) observed all year round. Wintering birds are observed from October and remain until early April with the identification of two regular post and pre-breeding passages (respectively in November and early December and late March/early April) for birds that winter further south in the highlands (Lazli *et al*., 2011b; Aissaoui *et al*., 2011). During these two periods, the maxi- mum number of the Anatidae is recorded (830 in December and 870 in March).

In general, during the wintering season, the *Aythya nyroca* are visible on open water surfaces between the tufts of *Typha angustifolia, Scirpus maritimus* and *Nymphaea alba*, while during the breeding season and after occupation of nesting areas, they are at a slight distance from nest bearing tufts.

During the breeding season, 49 nests were found on the shores of Lake Tonga. Nests are found in tufts of vegetation preferably composed of *Typha angustifolia* (74%), in tufts alone (27%), or mixed with *Cynodon dactylon* and/or *Scirpus maritimus* (Fig.2). The other nests were found in the large tussocks of *Phragmites australis* and on the tree trunks of *Alnus glutinosa* of the famous Lake Tonga alder forest (20% and 6% respectively). These areas of the lake have average depths ranging from 1.30 to 1.60 m. The nests are built in very dense vegetation. They are well covered and not very visible from above, making them inaccessible to air predators, especially the Marsh harrier *Circus aeruginosus*. The

majority of these nests required extensive excavation to find them. Only 6% were built on the edges of the islets and therefore visible.

Of the forty-nine nests found, we estimate a bio- logical reproductive success of around 80%. Success is higher in nests designed on islets (85%) because they are well covered by vegetation, which makes them less visible to aerial predators and far from the shoreline. Damage was higher in nests built in helophytic clumps (*Typha angustifolia* and *Scirpus maritimus*) and in Alder trunks (60%) which are accessible and poorly protected. The main predators are Marsh harriers and water snakes. Predation continues during the chick rearing period.

The main species that nest and build nests near those of the Ferruginous Duck are the White- headed Duck *Oxyura leucocephala*, the Purple swamphen *Porphyrio porphyrio*, two species classified as rare on the IUCN Red List, the Moorhen *Gallinula chloropus*, the Little bittern *Ixobrychus minutus* and to a lesser extent the Little Grebe *Tachybaptusruficollis* and the Great crested Grebe *Podicep scristatus.*

Nests are most often built on floating islets, in tufts of *Typha angustifolia* and/or *Scirpus maritimus* or on the trunks of the Glutinous Alder *Alnus glutinosa*. The floating islets are mainly composed of white willow *Salix alba*, Mediterranean willow *Salix pedicellata*, *Typha angustifolia* Small reed mace, simple stem burreed *Sparganium erectum*, Willow grass *Persicaria amphibia*, Yellow iris *Irispseudacorus*, Gypsywort *Lycopuseuropaeus*, Purple loosestrife *Lythrumsalicaria*, Common reed *Phragmites australis* and fireweed Chamerion angustifolium. These blocks occupy an average area of between 150 and 200 m^2. The average height of vegetation in islets varies between 3 and 3.5 m, especially if they contain Bulrushs, reeds and white willows (Abbaci 1999; Kadid *et al*., 2007).

The tufts are composed of Small reed mace *Typha angustifolia* or lake bulrush *Scirpus lacustris*, simplestem burreed *Sparganium erectum,* Yellow iris *Iris pseudocorus,* Purple loosestrife *Lythrum salicaria* or common reeds *Phragmites australis*. Generally, nests are composed of willow twigs, leaves of *Phragmites australis* and *Typha angustifolia,* European lycope *Lycopus europeus*, couch grass *Elymus repens* and are covered with fluff (Houhamdi *et al*., 2009; Baaziz *et al*.,2011; Lardjane-Hamiti*et al*., 2012; Bensizrara*et al*.,2013; Chettibi*et al*.,2013,2014; Aberkane*et al*.,2013, 2014; Bouzegag *et al*.,2013; Hallasi *et al*.,2016).

Nests are generally conical in shape and more or less elongated and are often 11.75cm [4-20] tall compared to water. Their external diameters range from 18 to 35.5 cm, with an average of 25.86 cm, internal diameters of about 16.46 cm [12.5-22] and an average depth of 9.44 cm [4.5-17]. The average inter-nest spaces are 5 m [1.37-22.84] and these nests are often far from the banks by an average of 736.72 m [1080.1-75.06].

Forty-nine nests were found during this breeding period. The farthest islets (1, 5, 6 and 7) contains between 8 and 11 nests. They are located between 500 and 1000 m from the shores of the lake. The tufts of *Typha angustifolia* and *Scirpus maritimus* generally border the banks of the water body, a distance varying between 75 and 80 m, and the tree trunks of the Alder trees are not far away (less than 200 m from the banks). They shelter between 1 and 3 nests.

The egg-laying period begins towards the end of April 2021 and lasts until the last week of June. The average number is 11 eggs/nest, (extremes 6 -16). Only one nest had 23 eggs. The average weight of the eggs is 40.6 g (minimum 39.8 g and maximum 41.8 g). Their average width is 3.4 cm and their average length is 5.2 cm.

Conclusions *(optional)*

Lake Tonga offers great potential for hosting many water birds both in winter and during the breeding season. It is the most important wetland in north- eastern Algeria. It hosts high numbers of diving ducks and surface ducks. The Ferruginous Duck, White-headed Duck *Oxyura leucocephala* and Mallard *Anas platyrhynchos* are sedentary species breeding in Lake Tonga. Two more or less distinct populations are observed during the year, one composed of 300 to 400 individuals is present all year round. The other, more consequent only frequents the water body during wintering. Clusters are also observed during pre- and postnuptial passages either to winter further south or to return to the usual breeding sites.

During the wintering season, the parts most used by this duck are the center of the body of water and the western sector. These areas are generally free of vegetation and therefore allow these water birds to gather and display their particular gregariousness. During the breeding season, these birds are distributed near tufts of *Typha angustifolia* and *Scirpus maritimus* and floating islets, which offer them great refuge. It is in these spaces that the Ferruginous Ducks build their nests. Generally speaking, these nests are preferably installed in the tufts of Typha and Typha mixed with other helophytes. These nests are well hidden in the vegetation, making them invisible to aerial predators. The nesting period is estimated to two and a half months, be- tween the last decade of April and the end of June.

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