

New biometric and breeding data for the Whiskered tern *Chlidonias hybrida hybrida* at its southern nesting limit: Lake Tonga (El-Kala, North-east Algeria)

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Received: 31 May 2024 / Accepted: 05 September 2024 / Available online: December 2024 / Printed: December 2024

Abstract. The biometry and reproduction of the Whiskered tern *Chlidonias hybrida hybrida* were studied in Lake Tonga (El-Kala, North-east Algeria), the only North African nesting site offering optimal conditions. Fifty-four nests were studied during the nesting period (2021). The results show that the nests are built on two plant supports (*Sparganium erectum* and *Nymphaea alba*). *Nymphaea alba* nests were deeper (106.360 cm) than *Sparganium erectum* nests (43.244 cm). The mean external nest diameter was greater for *Nymphaea alba* (37.364 cm) than for *Sparganium erectum* (32.186 cm). The laying period spanned five weeks, specifically from mid-June to the end of the second decade of July, totaling thirty-three days. Conversely, the laying period for *Nymphaea alba* was restricted to two weeks, starting from the commencement of July and concluding at the termination of the first decade of July, totaling nine days. The mean dates for laying were June 28 and July 04 for *Sparganium erectum* and *Nymphaea alba*, respectively. The mean clutch size was 1.93 eggs per brood and 1.82 eggs per brood for *Sparganium erectum* and *Nymphaea alba*, respectively. The mean width of the eggs was greater for *Sparganium erectum* (27.645 mm) than for *Nymphaea alba* (27.075 mm). These findings are consistent with those of the European population.

Keywords: *Chlidonias hybrida hybrida*, Lake Tonga, North-east Algeria, vegetation, biometry, reproduction.

Introduction

The *Chlidonias hybrida* is larger than the *Chlidonias niger* and the *Chlidonias leucopterus* (Etchécopar & Hüe 1964, Beaman & Madge 1998). The wings are slightly wider, the beak thicker, the tail more indented, and the legs slightly longer (Beaman & Madge 1998). It is a

migratory species, coming from Europe along the entire Mediterranean front (Etchécopar & Hüe 1964), little known (Latraube et al. 2006) and very little studied (Tomialojck 1994, Barati et al. 2010), especially in North Africa, where it regularly nests in Lake Tonga (Bakaria et al. 2002). The subspecies *Chlidonias hybrida hybrida* is known to reproduce in the middle and

temperate latitudes of the Western Palearctic, encompassing Western and Central Europe, the Near and Middle East, and marginally in North Africa, extending as far east as Western Russia and Kazakhstan (Bakaria 2013). This species builds its nests in the freshwater lakes and marshes of Northern Morocco (specifically at Ras El-Douara), Northern Algeria (especially around El-Kala), and Northern and Central Tunisia (Heim de Balzac & Mayaud 1962, Etchécopar & Hüe 1964, Isenmann & Moali 2000, Isenmann et al. 2005). Nests are built in colonies on various types of floating or emergent aquatic vegetation (Etchécopar & Hüe 1964, Trotignon et al. 1994, Debenest 2015). It uses floating plants, such as the water lily *Nymphaea alba*, which is the plant support par excellence for the establishment of the Whiskered Tern colony, and since physiognomic changes have been observed in recent years in the submerged generation of Lake Tonga, it changes nesting sectors every year in search of the most hospitable clumps. Whiskered terns were observed constructing their nests on clusters of *Sparganium erectum* found in these shallow habitats. This study seeks to present comprehensive data on the ecological behavior of this colonial species, particularly regarding nest construction and water depth, along with its

breeding biology, encompassing laying date, laying period, clutch size, and egg traits. The research specifically focuses on the exclusive breeding location of Lake Tonga in northeast Algeria within North Africa. Thus, we observed a connection between the choice of nest location within colonies and the presence of suitable vegetation for nest construction. We compared the bio-ecological parameters of reproduction between the two nesting areas, which were composed of different vegetation supports (*Sparganium erectum* and *Nymphaea alba*). We also compared them to previous studies in the same nesting area and to other studies in the Mediterranean basin.

Material and methods

Study site

The study was carried out in North-east Algeria, in the Lac Tonga, which is located at 36° 49' N; 8° 32' E in the extreme North-east of El Kala National Park (Wilaya of El Tarf, Algeria) (Figure 1), with an approximately ellipsoid shape and an area of 2600 ha; 7.5 km long, 4 km wide, and with an average depth of 70 cm (Bakaria 2013).



Figure 1. Geographical location of Lake Tonga.

The climate is Mediterranean, with a hot, dry season that lasts from May to November and wet weather for the rest of the year. Precipitation reaches 1000 mm per year. (Benyacoub & Chabi 2000).

Abundant aquatic vegetation plays a key role in the distribution of waterbird species and is mainly composed of islands of *Typha angustifolia*, *Iris pseudoacorus*, *Scirpus lacustris*, *Scirpus maritimus*, *Phragmites australis*, *Salix pedicellata*, and *Sparganium erectum*. Spring sees the emergence of *Nymphaea alba*, a highly invasive hydrophyte in open water areas (Abbaci 1999, Saïfouani et al. 2020).

Sampling protocol

The sampling procedure involved a systematic search for nests within the floating vegetation of the lake, starting in mid-May 2021. After locating the nests, we made observations on the nesting support and water depth and monitored various breeding parameters, including laying date, laying period, and clutch size. We measured the biometric parameters of the nests (Height above the water surface, external diameter, internal diameter, and depth of cup) using a tape measure. Additionally, we conducted egg measurements, using a caliper to determine egg length and width, and measuring mass with an electronic balance with an accuracy of 0.1 g.

Statistical analysis

Multiple treatments were conducted to assess the associations between the different parameters analyzed, including calculation of

means, standard deviations, extremes, and Pearson's correlation coefficient. The statistical analysis employed the student's t-test to compare the parameters. The statistical analysis was conducted using STATISTIX vers. 8.

Results

Construction support of the nest and water depth

During the course of the season, a comprehensive study was conducted on fifty-four nests belonging to the *C. h. hybrida*. The majority of the nests were found on two specific plant species: 79.63% on *Sparganium erectum* and 20.37% on *Nymphaea alba* (Figure 2). Mean water depths were 43.244 ± 6.770 cm and 106.360 ± 12.667 cm in *Sparganium erectum* and *Nymphaea alba*, respectively. The two zones exhibit a statistically significant distinction in mean water depth ($t=22.68$; $p=0.000$; $ddl=52$; THS^{***}). *Nymphaea alba* had nests installed deeper (Table 1).

Characteristics of the nests

The mean external nest diameter is 32.186 ± 6.780 cm and 37.364 ± 5.519 cm for *Sparganium erectum* and *Nymphaea alba*, respectively. There is a significant difference between the mean external nest diameter in the two zones during the breeding season ($t=2.34$; $p=0.023$; $ddl=52$; S^*); it is greater in *Nymphaea alba*. The mean internal nest diameter was 8.484 ± 2.351 cm and 9.891 ± 2.184 cm for *Sparganium erectum* and *Nymphaea alba*, respectively.



Figure 2. Nests of the Whiskered tern *Chlidonias hybrida hybrida* in Lake Tonga (pictures by M. Lemmoui): A. in *Sparganium erectum*; B. in *Nymphaea alba*.

Table 1. Construction support of the nest and water depth of the Whiskered tern *Chlidonias hybrida hybrida* in Lake Tonga.

Year	Vegetation		Water depth (cm)	
	<i>Sparganium erectum</i>	<i>Nymphaea alba</i>	<i>Sparganium erectum</i>	<i>Nymphaea alba</i>
2021	79.63% (43/54)	20.37% (11/54)	43; 43.244±6.770 (30-60)	11; 106.360±12.667 (90-130)
Student's t-test	/		t=22.68; p=0.000; ddl=52; THS***	

There was no significant difference in mean internal nest diameter between the two zones during the breeding season ($t=1.80$; $p=0.078$; $ddl=52$; NS). The mean nest depth was 2.849 ± 0.416 cm and 2.955 ± 0.270 cm in *Sparganium erectum* and *Nymphaea alba*, respectively. There was no significant difference between mean nest depths in the two areas during the breeding

season ($t=0.80$; $p=0.429$; $ddl=52$; NS). The mean nest height in relation to the water surface was 5.772 ± 1.535 cm and 5.364 ± 1.362 cm in *Sparganium erectum* and *Nymphaea alba*, respectively. There was no significant difference between mean nest height in relation to the water surface in the two areas during the breeding season ($t=-0.80$; $p=0.425$; $ddl=52$; NS). (Table 2).

Table 2. Characteristics of the nests of the Whiskered tern *Chlidonias hybrida hybrida* in Lake Tonga.

Zones	Characteristics n; Mean ± SD (Limits)			
	External diameter of nests (cm)	Internal diameter of nests (cm)	Depth of nests (cm)	Nests height/ to water surface (cm)
<i>Sparganium erectum</i>	43; 32.186±6.780 (13-48)	43; 8.484±2.351 (4-12)	43; 2.849±0.416 (1.5-3.5)	43; 5.772±1.535 (3-10)
<i>Nymphaea alba</i>	11; 37.364±5.519 (29-46)	11; 9.891±2.184 (5.2-12)	11; 2.955±0.270 (2.5-3.5)	11; 5.364±1.362 (4-9)
Student's t-test	t=2.34; p=0.023; ddl=52; S*	t=1.80; p=0.078; ddl=52; NS	t=0.80; p=0.429; ddl=52; NS	t=-0.80; p=0.425; ddl=52; NS

Laying date and laying period

The *Sparganium erectum* laying period lasted five weeks, from mid-June (June 15) to the end of the second decade of July (July 18), a laying period of thirty-three days, with a high frequency and a peak during the first two weeks of reproduction (June 15-June 29) (Figure 3A), whereas in *Nymphaea alba*, the laying period was spread over two weeks: from the beginning of July (July 01) to the end of the first decade of July (July 10), a laying period of nine days, with a high frequency and a peak during the first week of reproduction (July 01-08) (Figure 3B). The mean laying date

was June 28 (28.186 ± 11.813) and July 04 (34.455 ± 3.328) for *Sparganium erectum* and *Nymphaea alba*, respectively. There was no significant difference between the mean laying dates of the two zones ($t=1.73$; $p=0.089$; $ddl=52$; NS) (Table 3).

Clutch size

The mean clutch size was 1.93 ± 0.74 eggs per brood and 1.82 ± 0.60 eggs per brood for *Sparganium erectum* and *Nymphaea alba*, respectively. There was no significant difference between the mean clutch size in the two zones ($t=-0.47$; $p=0.644$; $ddl=52$; NS) (Table 4).

The most frequent clutches in *Sparganium erectum* were those of 2 eggs per brood, accounting for 46.50% (20 nests), with other clutches of 1 and 3 eggs per brood accounting for 30.20% (13 nests) and 23.30% (10 nests), respectively (Figure 4A). In the case of *Nymphaea alba*, the most frequent clutches were those of 2 eggs per brood, accounting for 63.60% (07 nests),

with other clutches of 1 and 3 eggs per brood, accounting for 27.30% (03 nests) and 9.10% (1 nest), respectively (Figure 4). There was no significant relationship between laying date and clutch size for Whiskered terns *Chlidonia hybrida hybrida* in *Sparganium erectum* ($r = -0.070$; $p = 0.657$; NS) (Figure 5A) and in *Nymphaea alba* ($r = 0.145$; $p = 0.671$; NS) (Figure 5B).

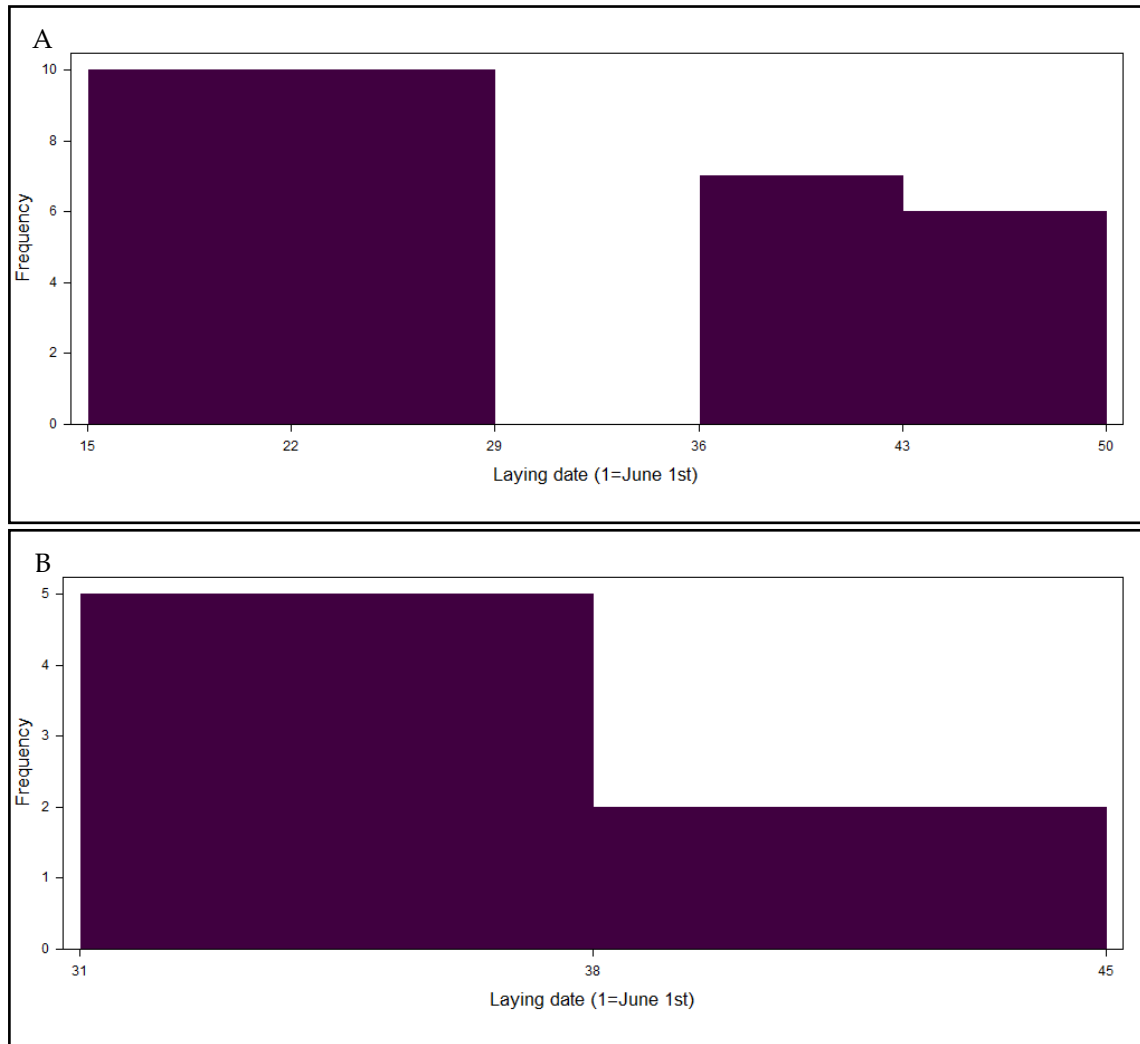


Figure 3. Egg laying chronology of the Whiskered tern *Chlidonias hybrida hybrida*. A: In *Sparganium erectum*; B: In *Nymphaea alba*.

Table 3. Mean laying date of the Whiskered tern *Chlidonias hybrida hybrida* in Lake Tonga.

Zones	Laying date (Days) n; Mean±SD (Limits)
<i>Sparganium erectum</i>	43; 28.186±11.813 (June 15-July 18)
<i>Nymphaea alba</i>	11; 34.455±3.328 (July 01-July 10)
Student's t-test	t=1.73; p=0.089; ddl=52; NS

Table 4. Mean clutch size of the Whiskered tern *Chlidonias hybrida hybrida* in Lake Tonga.

Zones	Clutch size n; Mean±SD (Limits)
<i>Sparganium erectum</i>	43; 1.93±0.74 (1-3)
<i>Nymphaea Alba</i>	11; 1.82±0.60 (1-3)
Student's t-test	t=-0.47; p=0.644; ddl=52; NS

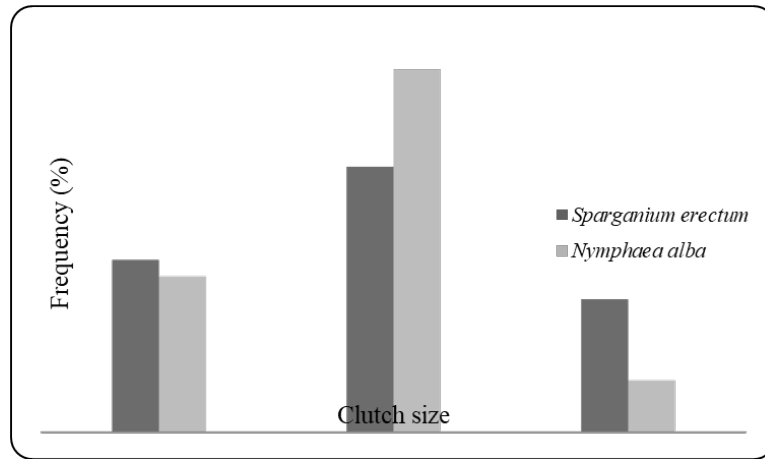


Figure 4. Clutch size proportions of the Whiskered tern *Chlidonias hybrida hybrida* in Lake Tonga.

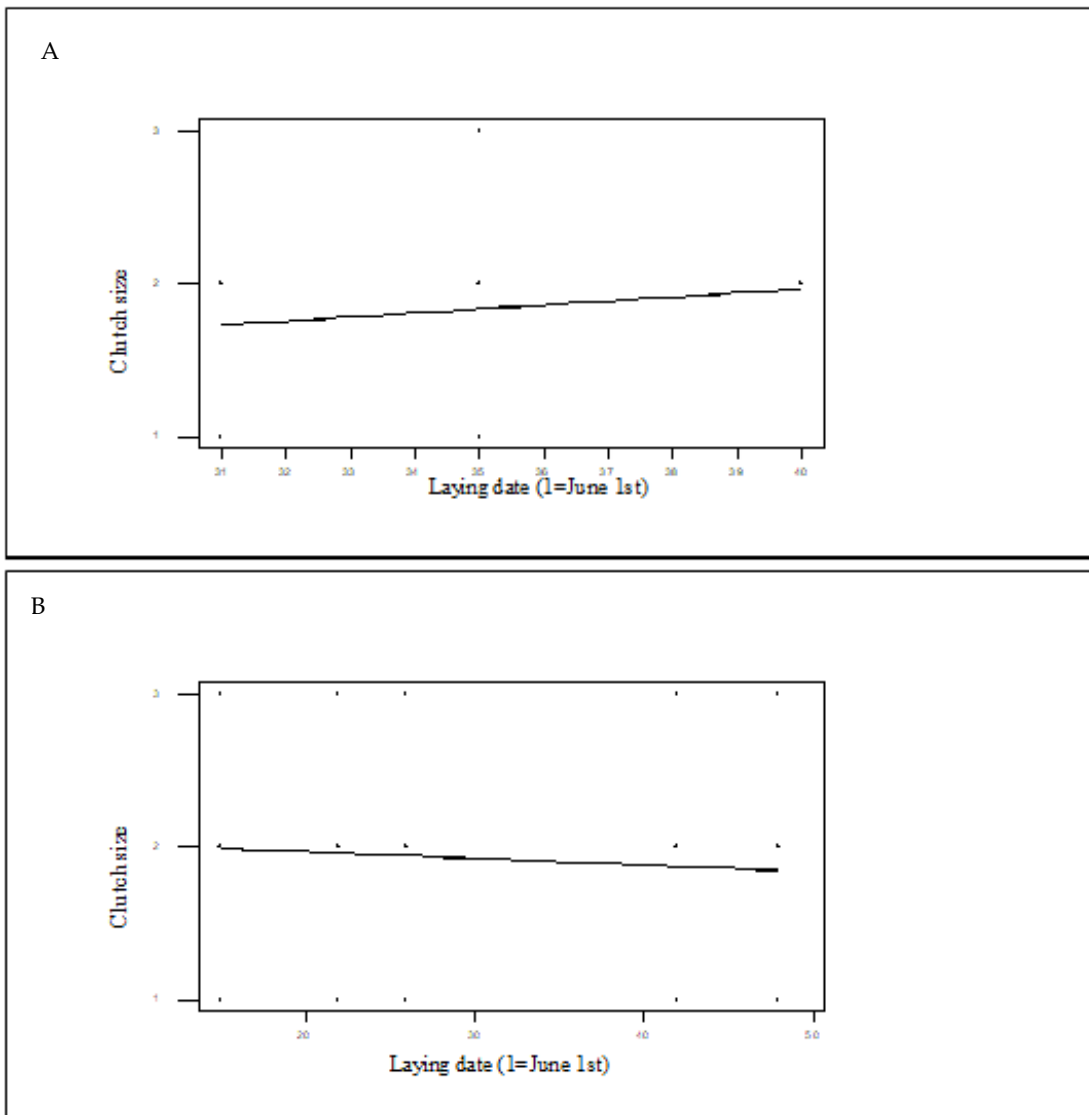


Figure 5. Relationship between laying date and clutch size in the Whiskered tern *Chlidonias hybrida hybrida*. A: In *Sparganium erectum*; B: In *Nymphaea alba*.

Characteristics of the eggs

The mean egg mass was 14.072 ± 1.091 g and 13.900 ± 1.071 g in *Sparganium erectum* and *Nymphaea alba*, respectively. There was no significant difference between the mean egg mass in the two zones during the breeding season ($t = -0.64$; $p = 0.526$; $ddl = 101$; NS). The mean egg length was 36.687 ± 2.625 mm and 37.225 ± 2.0678 mm in *Sparganium erectum* and *Nymphaea alba*, respectively. There was no

significant difference between the mean egg length in the two zones during the breeding season ($t = -0.85$; $p = 0.395$; $ddl = 101$; NS). The mean egg width was 27.645 ± 1.078 mm and 27.075 ± 1.030 mm in *Sparganium erectum* and *Nymphaea alba*, respectively. There is a significant difference between the mean egg widths in the two zones over the breeding season ($t = -2.14$; $p = 0.035$; $ddl = 101$; S*); it is greater in *Sparganium erectum* (Table 5).

Table 5. Characteristics of the eggs of the Whiskered tern *Chlidonias hybrida hybrida* in Lake Tonga.

Zones	Length (mm) n; Mean \pm SD (Limits)	Width (mm) n; Mean \pm SD (Limits)	Weight (g) n; Mean \pm SD (Limits)
<i>Sparganium erectum</i>	83; 36.687 ± 2.625 (32-41)	83; 27.645 ± 1.078 (26-29)	83; 14.072 ± 1.091 (11-16)
<i>Nymphaea alba</i>	20; 37.225 ± 2.068 (34-41)	20; 27.075 ± 1.030 (26-29)	20; 13.900 ± 1.071 (12-16)
Student's t-test	$t = -0.85$; $p = 0.395$; $ddl = 101$; NS	$t = -2.14$; $p = 0.035$; $ddl = 101$; S*	$t = -0.64$; $p = 0.526$; $ddl = 101$; NS

Discussion

The results of the present study on biometric variations during the breeding of the Whiskered tern *Chlidonias hybrida hybrida* in Lake Tonga (El-Kala, North-East Algeria) revealed that nests were built on two plant species (*Sparganium erectum* and *Nymphaea alba*). In contrast, the nests were built on a single plant species: *Nymphaea alba* in North-east Algeria (Lac Tonga) (Bakaria 2013) and *Juncus* in Southern Morocco (Lake Iriki) (Robin 1966, Thévenot et al. 2003). This difference is due to the fact that the nests of most water birds are largely influenced by fluctuating water levels (Elkins 1983, Bakaria 2013).

The characteristics of the nests (external diameter, internal diameter, and depth of the nests) in our work are different from those reported in France (Camargue) (Lomont 1945), Europe (Cramp & Simmons 1977), Italy (Spina 1986), Croatia (Muzinic & Délic 1997) and Algeria (Lac Tonga, North-east Algeria) (Bakaria

2013) (Table 6). It chooses a deep enough marsh where it can obtain, and this condition seems essential, floating stems and plant debris that it gathers to build a free raft in the center of which is drawn a small cup (Etchécopar & Hüe 1964). This difference is linked to the nature of the materials used for nest construction, which are available in the immediate vicinity of the nest at each site (Bakaria 2013).

Chronologically, the laying date of the present study (early July) is later than that reported in Northwest Africa (Ras-el-Daoura South of the Merdja Zerga, Morocco) and North Africa (early June) (Heim de Balzac & Mayaud 1962, Etchécopar & Hüe 1964), in European countries (mid-May and early June) (Snow & Perrins 1998, Bernard & Teyssier 2008), in Mediterranean regions (late May and early June) (Latraube 2006), in North-east Algeria (second decade of May to second decade of July - early June to mid-July) (Bakaria 2013, Isenmann & Moali 2000) and similar to that reported in

Tunisia (Lake Sejoumi) (early July (Isenmann et al. 2005). In the case of the Whiskered Tern *Chlidonias hybrida hybrida*, laying dates vary or depend mainly on the development of water lily leaves and climatic conditions at the start of the season (Spina 1986, Bakaria et al. 2002, Paillisson et al. 2006, Bernard & Teyssier 2008, Bakaria 2013).

Table 6. Nests measurements of the Whiskered tern *Chlidonias hybrida hybrida* in different parts of its range (in Bakaria 2013).

References	n	External diameter (cm)	Internal diameter (cm)	Depth of the nests (cm)
Lomont 1945	/	50	15-20	/
Cramp & Simmons 1977	/	75	20-30	2
Spina 1986	32	36	8	/
	11	36	7	/
	22	80	10	/
	10	23	7.2	/
Muzinic & Délic 1997	/	42	9	/
Bakaria 2013	150	49	15	1.80
Present study	43	32.186	8.484	2.849
	11	37.364	9.891	2.955

The clutch size in the present study (n=54; 1.88 (1-3) eggs per brood) is comparable to those reported in Algeria (Lake Fetzara, South-east of Bône; Lake Tonga, North-east Algeria) (n=2; 3.5 eggs per brood (3-4) - n=161; 2.5 eggs per brood - n=686; 2.6 eggs per brood - n=60; 2.68 (1-4) eggs per brood) (Heim de Balzac & Mayaud 1962, Rizi 1994, Bakaria 2013, Isenmann & Moali 2000), in North Africa (eggs are generally 3, sometimes 2 or 4 eggs per brood) (Etchécopar & Hüe 1964), in Southern Morocco (clutch size varies between 1-4 eggs per brood) (Robin 1966, 1968, Thévenot et al. 2003), in Italy (n=178; 2.6 eggs per brood - n=344; 2.16 eggs per brood) (Spina 1982, Fornasari 1992), in Croatia (n=121; 2.6 eggs per brood) (Muzinic & Delic 1997), in France (n=269; 2.6 eggs per brood - 2.2 eggs per brood) (Latraube 2006, Paillisson 2008) and in Romania (n=80; 2.7 eggs per brood) (Cazacu 2006).

The results obtained show that the characteristics of the eggs (n=103; 36.96x27.36; 13.99 g) are similar to those reported in several

works: in North Africa (n=16; 39x28.5 mm) (Etchécopar & Hüe 1964), in Europe (n=168; 39x28.2 mm) (Cramp 1985), in South Africa (n=49; 39.2x28.8) (Allan 1988), in Italy (n=100; 39.23x28.41 mm) (Spina 1982), in Algeria (Lake Tong, North-east Algeria) (n=350; 38.71x28.14 mm; 14.86 g - n=71; 38.55x28.1 mm - n=238; 38.63x28; 14.7 g) (Rizi 1994, Bakaria 2002, 2013), in Croatia (n=151; 38.4x28 mm) (Muzinic & Delic 1997) and in France (n=662; 38.52x27.86 mm; 14.73 g) (Latraube 2006).

Finally, the choice of nesting site is subject to strong selection by the population of the Whiskered tern *Chlidonias hybrida hybrida*. It uses another shallow helophyte (*Sparganium erectum*) for nesting instead of the usual *Nymphaea alba*. The mean external diameter of nests is greater in *Nymphaea alba*. The mean egg width is greater in *Sparganium erectum*. Our results are comparable with those obtained in North Africa and Europe. The population of the Whiskered tern *Chlidonias hybrida hybrida* is very selective in its choice of

nesting site. It prefers to nest on a different type of shallow helophyte (*Sparganium erectum*) rather than on the more typical *Nymphaea alba*. The average external diameter of the nests is larger on *Nymphaea alba* than on *Sparganium erectum*. *Sparganium erectum* has a larger average egg width. Our results are similar to those of North African and European populations. It would be interesting to study reproductive parameters such as the date and duration of hatching, hatching success, fledgling success, reproductive success, nest predators, adults, chicks, and nest parasites.

Acknowledgments

The authors would like to thank the MESRS and the DGRSDT for supporting this work through the PRFU project: N° D01N01UN240120230001.

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