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First report of *Cichlidogyrus cubitus* Dossou, 1982 (Dactylogyridea; Ancyrocephalidae) on *Tilapia zillii* in North West Africa

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ABSTRACT

For the first time in Algeria, we announce the presence of *Cichlidogyrus cubitus* (Monopisthocotylea: Dactylogyridea) on the gills of *Tilapia zillii* from Lake Temacine (Northern Algerian Sahara) in which 38 specimens were caught during samplings carried out in October 2012. The fish morphometric parameters Total Length (TL); Standard Length (SL); Cephalic Length (CL), body Height (H) in cm, and Total Weight (Wt in g) were measured. Prevalence, Mean Intensity and Abundance were estimated according to sexe, age and size of the host. 202 individuals of *C.cubitus* were collected, showing a global occurrence of 79%, a mean intensity of 6.7, and an abundance of 5.31. In females Cichlids, *C.cubitus* prevalence (90%) and abundance (6) were respectively higher than in males (64.7%; 4.5), and the mean intensity was 7 in males and 6.6 in females. Prevalence according to age varied considerably with 83% in fishes< 1year, 67% in fishes from 2 to 3 years, and 100% in fishes over 3 years. The prevalence was 100% in classes of TL [8.3-8.6[; [8.9-9.2[; [9.2-9.5[; [9.5-9.8 [, but was lower with 40% and 60% respectively in classes [8-8.3[and [8.6-8.9]. If considering the weight (Wt) of the fishes, *C.cubitus* prevalence varied considerably from 43% in 16g fishes, to 84% in 24g fishes, and to 100% in individuals between 8g and 16 g. The Chi-squared test showed no significant difference in the prevalence of *C.cubitus* according to sex, size classes, age classes and weight classes. However, the Generalized Linear Model analysis indicated that the variation of the number of individuals of *C.cubitus* is positively correlated with the Total Length, the age and the sex of *T.zilii* ($P < 0.001$), but the body weight has no statistical significance on the number of *C.cubitus* in the host.
KEYWORDS: *Tilapia zillii*; *Cichlidogyrus cubitus*; Prevalence, Lake Temacine; Algeria.

1. INTRODUCTION

In Algeria, the cichlid fishes *T.zillii*, *Oreochromis niloticus*, *Hemichromis fasciatus* and *Hemichromis bimaculatus* are reported, in the Northern Saharan areas, in various wetlands of the east, central and west parts of the country (Biskra, Tolga, Touggourt, Saida, Ain Skhouna, Bechar) [1, 2, 3, 4].
T.zillii although indicated as indigenous species in this country [5], has a wide distribution range from tropical to sub-tropical countries (35°N and 10°S, equating to temperatures of 7°-43°C) [6], including Benin, Cameroon, Central African Republic, Chad, Congo, Ivory Coast, Egypt, Gambia, Ghana, Guinea, Guinea-Bissau, Kenya, Liberia, Mali, Mauritania, Morocco, Niger, Nigeria, Senegal, Sierra Leone, Sudan, Togo, Tunisia, Uganda and Western Sahara [7, 8].
T.zillii is considered as Native to Africa and Eurasia, reaching 40.0 cm SL and 300g, and reportedly lives for 7 years [6, 9]). The status of this fish is considered as Least Concern "LC" according to the IUCN Red List [10]. Its presence in the Saharan areas reflects a time during which the geographical barriers between the water systems were less important than today with a fairly uniform distribution of the ichthyofauna occupying the tropical and the subtropical Africa [11].
Regardless of its invasive potential, *T.zillii* is herbivorous, feed on detritus, water plants, epiphyton, and some invertebrates [6], and has the ability to opt for alternative food sources. Actually, *T.zillii* and other cichlids *Oreochromis niloticus*, *O.mossambicus* and the African sharptooth catfish *Clarias gariepinus* represent the main species targeted by the aquaculture activity in the Saharan areas in Algeria [2, 12, 13, 14, 15].

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On the other hand, there is no published work on the parasitic fauna of the cichlids of north-west Africa [13, 16], and only few literature is available on the parasites of freshwater fishes in Algeria [13, 14, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27], whereas the parasitic fauna of the marine fishes is well documented [28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38]. Following the identification, for the first time in Algeria and in north-west Africa of the monogenean *C.cubitus* Dossou, 1982 (Dactylogyridea; Ancyrocephalidae) on *T.zillii* in Lake Temacine, it was imperative to investigate the parasitical patterns of this gill parasite.

2. MATERIALS AND METHODS

Sampling site

At 70 m of altitude above the sea level, Lake Temacine (33°00'46"N; 06°01'24"E) is located within the Valley of Oued Righ (Northern Algerian Sahara) (**Fig.1**). Its main water supply mainly comes from underground resources, and secondly from the surrounding oasis palm drainage [39]. The water levels vary depending on the season, with a maximum depth of 6m recorded in January.

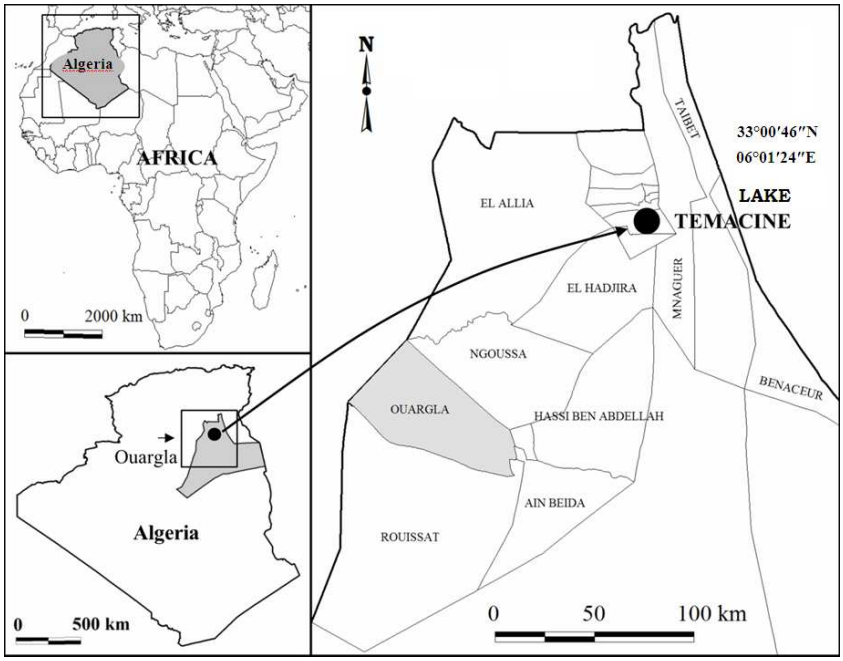

Figure 1: Geographic location of Lake Temacine (Northern Sahara, Algeria).

Lake Temacine is characterized by alkaline water (pH 8.0; Conductivity 38.2 µS/cm; Salinity 22.96‰) [40]. The local climate is hot and hyper-arid with slight variations during the year. The annual rainfalls do not exceed 100 mm, and July is the hottest month with 43.5°C main temperature while the lowest mean temperature 3.0°C was recorded in January [41].

Random samplings were carried out during October 2012, and 38 *T.zillii* were caught using a dipnet of 12mm x 13mm mesh size [42]. Measurements in cm concerned Total Length (TL); Standard Length (SL); Cephalic Length (CL), body Height (H), and the total Weight (Wt) in g [43, 44]. Fishes were immediately stored in a cool box containing ice block, and transferred to the laboratory where dissection was carried out during the same day of capture. The age of the fishes was determined by the scalimetry method [45, 46], and the identification of the cichlids was carried out according to Lévêque et al., 1990 [47]. The sex of each individual is recognizable through the observation of the gonads. The male testis are flattened and milky white, while in females the ovaries are fusiform to cylindrical and yellow to orange [48, 49, 50]. The sex ratio was estimated [51].

Parasitical investigation

The gills arches of each individual were isolated, and examined separately. They were immersed in distilled water, and thoroughly rinsed with distilled water to remove the excess mucous that builds up in the gill filaments. Observation under low magnification (x20) enabled the isolation of the monogeneans

from the gills. They were fixed in a drop of Malmberg solution (Ammonium picrate glycerin) and mounted between slide and slip cover [52]. Following microscopic observation (x40 to x400), identification of the parasites was made with the assistance of Dr Parisselle (URD, France), by measurements of the sclerotized parts of the accessory piece and the opisthaptor structures [53]. Microphotographs were taken using an Olympus SZH-10 stereomicroscope and a digital camera. Measurements of the body length, body width, and opisthaptor width are given in micrometers.

Statistical analysis

Prevalence, mean intensity, and abundance were estimated according to the literature [54, 55]). Minitab Ver. 13.31 (2013) software was used for statistical analysis. The comparison of the prevalence was performed with the chi-square test. A Generalized Linear Model (GLM) was applied in order to investigate the correlations between the parasite number and the host-related parameters (height, age, weight and sex) as indicated by Fox [56].

3. RESULTS

Morphometric characters of Tilapia zillii

The TL of *T. zillii* ranged from 8 to 10 cm (Mean = 9.10 ± 1.41 cm), the SL from 6.2 to 8.5 cm (Mean = 7.32 ± 1.62 cm, and the mean weight was 14.47g (± 9.82g). The sex ratio was 1:0.8 in favour of the females (**Tab.1**).

Table 1: Morphometric measurements of *Tilapia zillii* from Lake Temacine, Algeria.

Parameters	Minimum	Maximum	Mean ± SD
Total Weight Wt (g)	9.3	23.2	14.47 ± 9.82
Total Length TL (cm)	8	10	9.10 ± 1.41
Standard Length SL (cm)	6.2	8.5	7.32 ± 1,62
Cephalic length CL (cm)	1.6	3	2.37 ± 0.98
Body Height BH (cm)	2.3	3.5	2.86 ± 0.84
Age (year)	1	3	2.13 ± 1.41
Sex-ratio		17 / 21 (1: 0.8)	

Identification of Cichlidogyrus cubitus from the gills of Tilapia zillii

During this survey, 202 specimens of *C.cubitus* **(Fig.2,3,4)** were collected from 38 *T.zilli.* Measurements are as follows. Body Length = 45 – 80 ± 8.3 µm; Body Width = 8 – 27 ± 6.2 µm; Opisthaptor Width = 7 – 23 ± 4.6 µm, (N = 24).

Figure 2: *Cichlidogyrus cubitus* Dossou, 1982 gill parasite of *Tilapia zillii* in Lake Temacine, Algeria.

Figure 3: Accessory piece smooth and equal of *Cichlidogyrus cubitus*
Host: *Tilapia zillii* in Lake Temacine, Algeria.

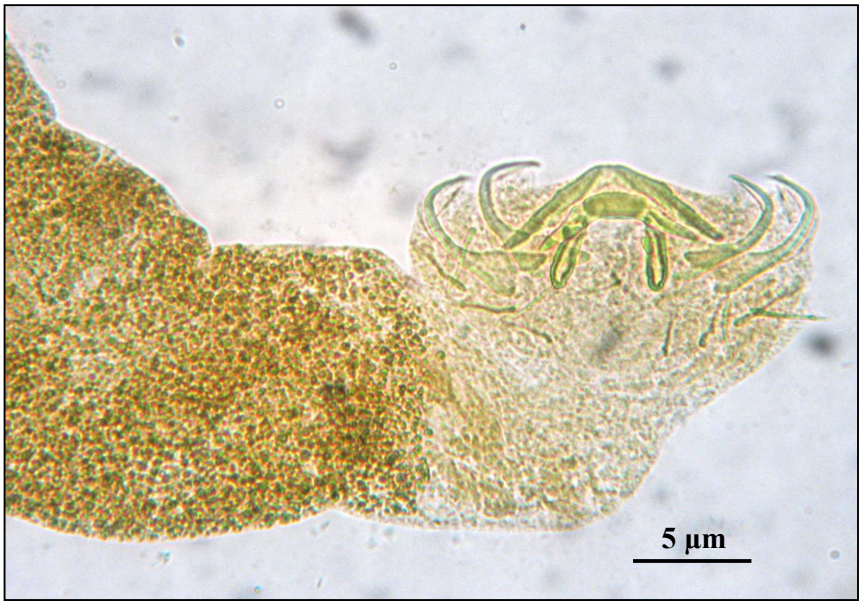

Figure 4: Opisthaptor of *Cichlidogyrus cubitus* with large bar auricles.
Host: *Tilapia zillii* in Lake Temacine, Algeria.

Parasitic rates and sex of the host

Prevalence in females (90%) was higher than in males (65%), with a mean intensity of 7 in males and 6.6 in females. The abundance of *C.cubitus* in females was 6 and 4.5 in males. The Chi-squared test showed no significant difference in the prevalence of *C.cubitus* according to the sex of *T.zillii* (Ddl= 1; $\chi 2$= 3.75, P= 0.053).

Parasitic rates and age classes

The prevalence of *C.cubitus* was 83% in individuals< 1 year, 67% in fishes from 2 to 3 years, and 100% in fishes over 3 years. The mean intensity was 11 while the abundance was the highest (10.6) in fishes

from 2 to 3 years. The chi-square test showed no significant difference in the prevalence of *C.cubitus* according to the fishes age (Ddl = 2; $\chi 2 = 4.90$; P= 0.068).

Parasitic rates and weight classes

Fish of all weight classes (**Tab.2**) were found infested by *C.cubitus*. The prevalence increased with the weight of the fishes, and in individuals weighting between 16 and 24g the prevalence was 100%, whereas the minimum values of the mean intensity (3.33) and abundance (1.43) were recorded in fishes of weight class between 8 and 12 g. In all other weight classes, the values of the mean intensity and abundance were higher than 4.63. The Chi-squared test showed no significant difference in the prevalence of *C.cubitus* according to the weight classes (P= 0.88).

Table 2: Parasitic rates of *Cichlidogyrus cubitus* according to the weight classes of *Tilapia zillii* in Lake Temacine, Algeria.

Weight classes (g)	Number of fishes	Prevalence	Mean intensity	Abundance	Ddl	χ^2	*P*
[8– 12[	7	43%	3.33	1.43	4	9.48	0.88
[12- 14[	8	75%	6.17	4.63			
[14- 16[	12	83%	5.90	4.92			
[16- 18[	7	100%	9.71	9.71			
[18- 24]	4	100%	7.00	7.00			

Parasitic rates and size classes

Within all classes (**Tab.3**), the mean intensity ranged from 3.5 to 10, and the abundance from 1.4 to 10 with the maximum values recorded in fishes having TL>9.5 cm. The prevalence in classes [8 - 8.3[and [8.6 - 8.9[was respectively 40% and 67%, but was 100% in all others classes. The Chi-squared test showed no significant difference in the prevalence of *C.cubitus* according to the size classes (Ddl= 5; $\chi 2$= 10.72 P= 0.057).

Table 3: Parasitic rates of *Cichlidogyrus cubitus* according to the size classes of *Tilapia zillii* from Lake Temacine, Algeria.

Size classes (cm)	Number of fishes	Prevalence	Mean intensity	Abundance	Ddl	χ^2	*P*
[8-8.3[	5	40 %	3.5	1.4	5	10.72	0.057
[8.3-8.6[	3	100 %	2.6	2.6			
[8.6-8.9[	15	67 %	5.9	3.9			
[8.9-9.2[	1	100 %	2	2			
[9.2-9.5[	7	100 %	8	8			
[9.5-9.8]	7	100 %	10	10			

Correlations between the parasitic load of C.cubitus and the morphometric parameters of Tilapia zillii

The GLM (**Tab.0**) indicates that the variation of the number of individuals of *C.cubitus* is positively correlated with the Total Length, the age and the sex of *T.zilii* (P <0.001). It is also negatively correlated to the Total Length versus Sex (TL × Sex, P <0.001), while the numbers of *C. cubitus* showed no significant correlation with the total weight, the Standard Length, the Cephalic Length or the body Height. Indeed, there is no significant correlation between the numbers of *C. cubitus* and the late mentioned parameters versus Sex.

Table 6: Results of the GLM testing the effect of the morphometric parameters of *T.zillii* on the number of *Cichlidogyrus cubitus* in Lake Temacine, Algeria. (SD: Standard Deviation).

Parameters	Estimate	SD	z-value	*P* value
Intercept	-26.89	6.56	-4.10	<0.001***
LT	3.20	0.71	4.50	<0.001***
LS	-0.54	1.16	-0.46	0.643
LC	1.40	1.14	1.22	0.222
HL	-0.91	1.10	-0.82	0.412
Wt	-0.06	0.16	-0.39	0.700
Age	1.20	0.25	4.76	<0.001***
Sex	24.60	6.73	3.66	<0.001***
LT × sex	-3.13	0.76	-4.09	<0.001***
LS × sex	1.18	1.20	0.98	0.325
LC × sex	-2.55	1.21	-2.10	0.036*
LH × sex	0.75	1.19	0.64	0.524
Wt × sex	0.09	0.17	0.49	0.624
Age × sex	-0.61	0.32	-1.93	0.054

4. DISCUSSION

Very recent additional taxonomic data includes 71 members for the genus *Cichlidogyrus* Paperna, 1960 [57, 58], gill parasites of Cichlidae and Nadidae [59]. In this genus, 13 species are reported parasites of *T.zillii*: *Cichlidogyrus arthracanthus* (Type species), *C.cubitus*, *C.aegypticus*, *C.anthemocolpos*, *C.digitatus*, *C.ergensi, C.ornatus, C.tiberianus, C.vexus, C.yanni*, *C.sclerosus*, *C.halli typicus*, and *C.tilapiae*, [47, 59, 60, 61].

Cichlidogyrus cubitus is found parasitizing the gills of 8 Cichlids *T.zillii, T.busumana, T.dageti, T.guineensis, T.louka*, *T.walteri*, *T.buttikoferi*, and *T.mariae*, with a geographical distribution ranging from the tropical to the sub-tropical areas of west Africa including Senegal, Ivory Coast, Benin, Guinea and Congo [47, 53, 59]. This first discovery of *C.cubitus* in the northern part of the Algerian Sahara and North Africa reflects its establishment beyond the Sahara desert linked to the presence of its fish host.

In Central, West, and South Africa, most of the published works are dealing with taxonomic and epidemiological studies of monogeneans in Cichlids [53, 61, 62, 63, 64, 65, 66, 67, 68, 69]. However, very few are devoted to *C.cubitus*, mostly dealing with systematic descriptions or reports of presence in host [47, 59, 60, 70, 71,]. There is no work on the parasitism incidence of *C.cubitus* on the *Tilapia zillii* population. The results of the present survey represent the first detailed data on the parasitic patterns of *Ciclidogyrus cubitus* in *T.zillii*.

Parasitism and sex

Our results indicate that *T.zilii* males are more infested by *C.cubitus* than females. In the tropical river Warri in Nigeria, cichlid females are reported more infested than males [65]. According to Simkova et al [72], when compared to male fishes, the high infestation in females is linked to their spawning activity. These authors indicated a positive correlation between the abundance of *Gyrodactylus spp*. and both gonad mass and GSI in females. Indeed, their results suggest that the females are more susceptible to parasite infection in periods of higher reproductive investment, supporting the hypothesis of these later authors that the parasite life cycle could be synchronized with the beginning of the host reproduction, probably induced by the increase of hormone levels during the spawning season. Meanwhile, Pennycuick [73] suggests that the oestrogenic activity seems to protect the females against the parasitic infestation.

On the other hand, the male fishes are supposed to be more susceptible to parasites because their immune response is suppressed by testosterone. Rohlenova and Simkova [74] indicated that spawning males *Leuciscus cephalus* (Cyprinidae) were more susceptible to parasite infection and had smaller spleen size due to immunosuppression by steroid hormones. These authors reported that during spawning, the sexual ornamentation in fish males seems to reflect a higher parasite infestation because of the role of steroid hormones that in one hand stimulate the increase in the expression of sexual ornamentation, but on the other hand, they decrease the resistance and immune defence of individuals by immunosupression. These indications corroborate with various sources [75, 76, 77, 78] indicating that *T.zillii* males are more susceptible to infection that females, following secretion of testosterone, which causes the decrease in immune activities. Rohlenova and Simkova [74] pointed out that the abundance of Monogenea in *Leuciscus cephalus* reached relatively high values in before-breeding period, subsequently decreased in breeding, and finally switched over to maximal values in after-breeding period although that no correlation was found between measured immune variables and infection of Monogenea.

The effect of territorial defence and competition are considered as the major factors in the weakening of *T.zillii* males to parasitic attacks [65, 75]. During the breeding season and the competition between males, the high levels of testosterone promote immune-suppression, and thus increase susceptibility to infestations [79]. The courtship behaviour of *T.zillii* males digging nests as well as parental care devoted to eggs promote contacts with the females and the benthic fauna favouring the transmission of parasites [80]. The influence of sex on parasitism by monogeneans was also studied in *Sarotherodon melanotheron* [64], and in *Hemichromis fasciatus* [62, 63].

Parasitism and fish age

In Lake Temacine, the parasitism levels of *C.cubitus* in *T.zillii* increase with age, and similar occurrence is well reported in fishes [61, 81, 82]. During this survey, the high occurrence of *C.cubitus* in older fish can be explained by the repeated infestation, the accumulation of parasites, as well as by the availability of the large surfaces of the gill filaments [61, 83]. In Nigeria, adult *T. zillii* were mostly infested, followed by juveniles [76]. According to Akinsanya et al. [84], the parasitism rate is primarily related to the immune system of individuals. Heavy infestations are also recorded in juvenile *Haplochromis* (Cichlidae) and *Micralestes* (Alestiidae) in Kazinga Channel and Lake Volta in Ghana [81].

Parasitism and fish weight and size

Our results show that the variation of occurrence of *C.cubitus* in *T.zillii* is not related to the weight of the fish as similarly indicated in Nigeria by Olurin and Somorin [85]. However, high levels of parasitism can induce a reduction in the weight of the fish [78, 83]. Comparatively, the parasitic intensity of the protozoan *Ichthyophthirius multifiliis* (Hymenostomatida) on the gills of *Arapaima gigas* (Osteoglossidae) increases with the weight [86]). Other indications refer the increase of prevalence of *Cichlidogyrus sclerosus* and *Cichlidogyrus sp*. to the accumulation processes and to the increase in the gill surface with the weight [87, 88, 89].

It should be noted that the relationship between the size and weight of *T.zillii* caught in Lake Temacine is isometric [40]. In addition, the exposure time of the gills of fish to infestation could explain the fact that large weight individuals are more parasitized [64]. Our results indicate that fishes of large size are the most infested. The large number of monogeneans observed on the gills is related to the availability of the larger surface on the gill filaments as indicated before. According to Bichi and Ibrahim [90], the surface is proportional to the total length of the fish. This may justify the change in the number of *C.cubitus* depending on the total length of *T.zillii*.

Our results also corroborate with those of Tombi and Bilong-Bilong [83]), who noted that the number of monogenean gill parasites of *Barbus martorelli* (Cyprinidae) in Cameroon increases with the size of the fish. However, Gbankoto et al. [75] indicated that the size of the fish has no effect on the parasitism. In consistency with the similar findings of Violente-Gonzales et al. [91], Ibrahim [61] confirmed that the monogenean parasitism is positively correlated with the host body size of *T.zillii*.

Regarding the short period and the limited size of our samplings, the present parasitic epidemiological survey in Lake Temacine is providing a preliminary understanding of the occurrence of *C.cubitus* in *T.zillii*. It also open prospects for further investigations in the wetlands of the Algerian Sahara in order to establish the distribution, and the seasonal dynamics of *C.cubitus* in *T.zillii*, as well as for the Protozoan and Metazoan parasitic fauna of the cichlid fishes. These investigations are very useful for the knowledge of community structures of the parasites, and for estimating their potential threat towards the fish population. The monogenean parasitism can be lethal to fishes as the attachment of the opisthaptor structures in the gills filaments induces deep injuries in the epithelial layer causing proliferation of epithelial tissue (hyperplasia), epithelial histopathology, haemorrhage, hyper-secretion of mucus surrounding the gills, respiratory disturbance as well as collateral infections [13, 92, 93].

If the dominant social activity in the area of Lake Temacine is the oasis agriculture and the culture of the date palm *Phoenix dactylifera*, the implementation of a traditional farming of cichlids, will be an opportunity to improve the local economic activity, to supply the traditional agricultural activities with water, to insure a better fertilization of the soil, and to furnish the local markets with fishery products.

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