ROAD MORTALITY OF THE ALGERIAN HEDGEHOG (*ATELERIX ALGIRUS*) IN THE SOUMMAM VALLEY (ALGERIA)

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RÉSUMÉ. — *Le Hérisson d'Algérie (*Atelerix algirus*) dans la vallée de la Soummam (Algérie) : étude de la mortalité due au trafic routier*. — Les causes de mortalité des populations d'animaux sauvages sont variées mais une des plus importantes chez les espèces de taille moyenne est due à la circulation routière. En Europe de l'Ouest, en relation avec l'existence d'un réseau routier dense, le Hérisson est une des espèces communes les plus touchées par le trafic routier. Dans les pays d'Afrique du Nord, et en particulier en Algérie, le parc automobile et les réseaux routiers se sont développés considérablement ces dernières décennies. Le Hérisson d'Algérie (*Atelerix algirus*) est une des principales espèces victimes du trafic routier dans la vallée de la Soummam (entre Béjaia et Bouira). Le long de cet axe routier d'environ 100 km à très fort trafic, nous avons pu relever pendant 5 ans (de 2002 à 2006) le nombre de hérissons trouvés morts. Les relevés effectués régulièrement, chaque semaine, ont permis de dénombrer 459 animaux écrasés. La répartition des animaux par localité a montré que le Hérisson est très fréquent à la périphérie des agglomérations présentant des milieux diversifiés : zones forestières, parcelles cultivées, haies, bocages bordés par les affluents de l'Oued El Soummam. Au cours de l'année, chez le Hérisson, la mortalité routière est maximale au printemps et en été (42,92 et 34,64 % respectivement), décroît en automne et est minimale en hiver (5,66 %). Chez 404 animaux, il a été possible de déterminer le sexe et l'âge. Ainsi, nous avons pu préciser que les mâles sont observés régulièrement les premiers, au printemps à partir de mars et que, pendant cette période, plus de mâles que de femelles sont trouvés morts (45,30 % et 31,19 % respectivement). Chez les mâles, cette forte activité locomotrice printanière (maximum en mai) et estivale est à relier à la période de reproduction et au fait que leur domaine vital est plus grand que celui des femelles. Les jeunes sont surtout trouvés en fin d'été et en début d'automne (23,51 %), période qui correspond à la dispersion et à la recherche de nourriture avant l'hiver. L'activité moindre en fin d'automne, puis réduite en hiver, est à relier aux conditions défavorables du milieu et à des stratégies de conservation d'énergie incluant des épisodes de vie ralentie. Ces résultats montrent des variations saisonnières nettes de l'activité locomotrice du Hérisson d'Algérie et reflètent des variations physiologiques précises comme la reproduction (au printemps et en été) et des épisodes de torpeur (en automne et en hiver).

SUMMARY. — There are several reasons for mortality in a population of wild animals, but the most important in small animals is the mortality due to the road traffic. Because of the dense road network the hedgehog is in Western Europe one of the species most affected by road kills. In North-African countries and particularly in Algeria, both the road network and the number of cars have considerably increased in the last decades. Thus, the number of Algerian Hedgehogs (*Atelerix algirus*) victims of the traffic is high and regular. Along a road of *ca* 100 km with high traffic volume, localized in the Soummam valley (from Béjaia to Bouira), we recorded during 5 years (from 2002 to 2006) the number, places and dates of hedgehogs found killed. The road was surveyed from a car, three times a week, and the overall number of hedgehogs

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found killed was 459. The distribution of animals respective to their location showed a very high density in suburban areas with their diverse environmental structures such as forests, agricultural areas, hedges, and the woodlands around the wadi El Soummam tributaries. In the course of the year, the hedgehog road kills were maximal in spring and summer (42.92 and 34.64 % respectively), decreasing in autumn and reaching a minimum in winter (5.66 %). It was possible to determine the age and sex of 404 animals. Every year males were observed first in spring from March onwards. During this period more males than females were found dead (45.30 % and 31.19 % respectively). The strong locomotor activity of males in spring (maximum in May) and summer coincides with the period of reproduction. Additionally, their home range is larger than that of females. Juveniles were found mostly at the end of summer and the beginning of autumn (23.51 %). This period corresponds to dispersion and foraging for winter. At the end of autumn, the activity started to decrease and was further reduced in winter in order to save energy during the adverse times of the year. In this period it is likely that the animals reduce their metabolism and hibernate. These road kill data in Algerian hedgehogs reflect precisely the seasonal variations of locomotor activity, and physiological variations such as reproduction (in spring and summer) and hibernation (autumn, winter).

Reasons underlying mortality in wild species are of various origins: natural (climate, diseases, parasites, predation, etc.) or unnatural as a consequence of human activities (hunting, road kills, pesticides, etc.) (Reeve & Huijser, 1999). Road kills depend on the density of the road network, and the increase of traffic intensity. Thus, the traffic impact on different wild populations has been the subject of numerous studies. The road network modifies and fragments the habitat and introduces artificial barriers. Furthermore, road kills might significantly diminish the population of different zoological groups (including insects, amphibians, reptiles, birds and mammals: Mader, 1979; Holsbeek *et al.,* 1999; Hels & Buchwald, 2001; Clevenger *et al.,* 2003). Within mammals, the Hedgehog (*Erinaceus europaeus* L.), which is one of the most common species in Western Europe, is also a frequent traffic victim (Reeve, 1994; Huijser & Bergers, 1998; Huijser, 1999; Reeve & Huijser, 1999). In different European countries, the number of hedgehogs killed on the road is estimated in general at 1-3 animals/km/year (Göransson *et al.,* 1976; Berthoud, 1980; Garnica & Robles, 1986; Huijser *et al.,* 1998), or even up to 5.6 animals/km/year (Reeve, 1994; Orlowski & Nowak, 2004) depending on the density of the road network. In spite of a large variability, results of these studies all indicate a reduction of hedgehog populations (Sweden: 17-22 % Göransson *et al.,* 1976; 15 % Kristiansson, 1990; Switzerland: 26 % Morris & Berthoud, 1987; The Netherlands: 30 % Huijser & Bergers, 2000). The observed variations could be related to different parameters such as traffic intensity (Huijser, 1999; Orlowski & Nowak, 2004), the structure of the environment (Huijser, 1999; Somers & Verhagen, 1999), the season of study (Kristiansson, 1990), etc. Indirectly, these studies also deliver information on the different variables of the population such as: the density and distribution of the species in a region or a given environment, the dynamics of the population and its seasonal variations, the sex and age of the animals, the course of seasonal cycles such as reproduction or hibernation, etc.

In Algeria, the road network and traffic intensity have increased during last recent decades as in western European countries. The users of roads which traverse forests and the surroundings of the wadi report numerous crushed animals. The Algerian Hedgehog (*Atelerix algirus*) is a regular traffic victim, especially in spring and summer. As in Algeria no study had been done on this subject, we recorded the number of hedgehogs which got run over during 5 years along a frequently used road in the Soummam valley. The distribution of crushed hedgehogs along the road permitted determining the habitats and sensitive areas. Additionally, the determination of sex and age, and the distribution of the different categories in the course of the year allowed us to elucidate some unknown aspects of the biology of this species (i.e. locomotor activity, timing of reproduction and hibernation, etc.).

MATERIAL AND METHODS

The Algerian Hedgehog (*Atelerix algirus*) is a species with a large distribution from plains along the Mediterranean coast to the surrounding Atlas Mountains and Saharian tablelands (Sahraoui–Brahim, 1984; Sellami *et al.,* 1989). The occurrence of the hedgehog was frequently observed in the Soummam valley, a typical haunt of this species, with no particular arrangements to protect fauna. The Soummam valley is a link from the Mediterranean coast (Béjaia)

to the foothills of the Djurdjura mountains (Bouira), and is a socio-economic district in north-eastern Algeria. It is predominantly devoted to agriculture with a mixture of large farms and small scale agricultural fields, but it is also a quite diversified ecosystem with woodlands, a dense network of streams and small villages and large urban agglomerations. It also has an important road network with a high traffic volume (about 13 000 to 22 000 vehicles per 24 h), characterized by narrow roadways with grassy borders and hedges which are preferred habitats of hedgehogs.

From Béjaia to Bouira (Fig. 1), along the 100 km of this road axis, we collected, over the course of 5 years (from 2002 to 2006), the hedgehogs found killed on the road. The road was surveyed from a car driven at low speed and checked regularly (3 times a week). Exceptionally, on some road section with numerous dead animals, these observations were done on foot for security reasons, but with no effect on the collection as the animals were only taken on the roadway. In view of the fact that the hedgehog is a nocturnal animal, bodies were collected regularly in the early morning. This also reduced their further damage by passing cars or their displacement by stray dogs and the removal by potential scavengers (jackals, foxes, mongooses, owls).

For each animal date, location, the immediate vicinity, sex and age (adult males or females, juveniles of the current year) were noted. The distribution of the hedgehogs killed on the road has been reported for the investigation area, which was divided into ten sections of 7-12 km in order to determine the habitats and the high risk areas in relation to different landscapes. The general data on hedgehog road kills are given as a function of time (years, months, and seasons) and analysed in relation to sex and age (adult males or females, juveniles of the current year).

An index of road mortality (I_{mr} = number of bodies per kilometre and year) was calculated: $I_{mr} = 365*c / s*d$. The number of cadavers c found during the year in the period s (in days) over the distance d (in km). In the course of the year, the ambient temperature variations may modulate the intensity of foraging activity of Algerian Hedgehogs or the phenomenon of hibernation which we reported recently in this species (Mouhoub *et al.,* 2006, 2008). During the period 2002-2006 the means of monthly temperature maxima (Ta_{Max}) and minima (Ta_{min}) were provided by the meteorological station of the airport of Béjaia. We analysed the effect of seasonal and yearly variations of Ta on the road kills of hedgehogs.

The data are presented as percentage or the mean ± Standard Error of the Mean (mean ± SEM) and analysed by a one-way or two-way variance analysis (ANOVA, software STATISTICA, StatSoft Inc., Tulsa OK 74104, USA). *Post hoc* comparisons were made by the LSD-test (significant difference $P < 0.05$).

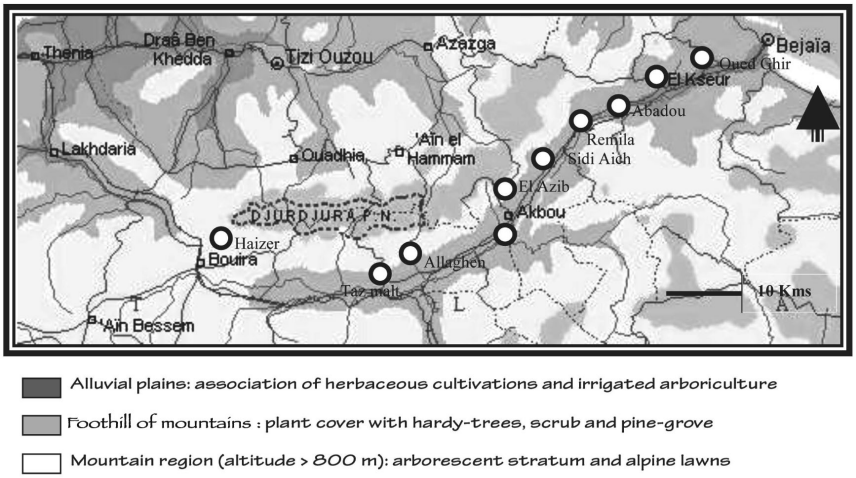

Figure 1. — Road along the Soummam valley (from Béjaia to Bouira) surveyed for Algerian Hedgehogs (*Atelerix algirus*) killed by traffic. Circles indicate the different road sections.

RESULTS

General data on the number on road kills of Algerian Hedgehogs in the Soummam valley

During the 5 years of our study (from 2002 to 2006), 459 hedgehogs were killed by collision with a car on the traffic axis through the Soummam valley. In the different years, the number of dead animals was irregular and varied widely (maximum 134 in 2002 and minimum 59 in 2005) (Tab. I). The same was found for the road mortality index (cadavers/km/year) of which the maximum (3.13) was observed in 2002 at the beginning of our study and the minimum (1.38) in 2005.

TABLE I

Number of hedgehogs killed yearly, from 2002 to 2006, in the Soummam valley

Years	2002	2003	2004	2005	2006	*Total*
n	134	98	62	59	106	*459*
%	29.19	21.35	13.51	12.85	23.09	*100*
I_{mr}	3.13	2.29	1.45	1.38	2.48	*10.74*

n = number of animals; % = percentage; I_{mr} = Index of road mortality [cadavers/km/year]

In terms of zone, the number of hedgehogs killed on the road is more pronounced in the periphery (between 10 and 30 %) of sparsely populated small villages such as Abadou, El Azib, Allaghen (~ 10 %), Remila, (> 20 %), and Haizer (> 30 %) (Tab. II ; Fig. 1). In contrast the number of crushed animals is smaller in the vicinity of strongly urbanized large agglomerations like Oued Ghir, El Kseur, Sidi Aich, Akbou and Tazmalt (Tab. II ; Fig. 1).

TABLE II

Road kills of Algerian Hedgehogs between Béjaia and Bouira from 2002 to 2006: distribution of 459 crushed animals according to the defined road sections

Years	2002 (n)	2003 (n)	2004 (n)	2005 (n)	2006 (n)	Total	*%*
Oued Ghir	11	6	5	3	6	31	*6.75*
El Kseur	3	2	1	1	1	10	*2.18*
Abadou	12	12	8	5	9	46	*10.02*
Remila	24	20	14	18	27	103	*22.44*
Sidi Aich	4	3	3	2	3	15	*3.27*
El Azib	14	8	1	6	14	43	*9.37*
Akbou	3	1	2	3	3	12	*2.61*
Allaghen	13	10	5	5	11	44	*9.59*
Tazmalt	5	2	3	2	3	15	*3.27*
Haizer	45	34	20	14	27	140	*30.50*

n = number of animals per year and per section; total and percentage par section from 2002 to 2006. Sections of Remila and Haizer *vs* other sections: $P < 0.05$.

SEASONAL AND MONTHLY DISTRIBUTION OF ROAD KILLS OF ALGERIAN HEDGEHOGS IN THE SOUMMAM VALLEY

The seasonal mean (Fig. 2a) of dead hedgehogs of the years 2002 – 2006 was minimal in winter (5.20 ± 2.72 ; 5.66 %), maximal in spring (39.40 ± 12.06 ; 42.92 %), at high levels in summer (31.80 ± 3.85 ; 34.64 %) (spring and summer *vs* winter $P < 0.05$; spring *vs* autumn $P < 0.05$), and decreased in autumn (15.40 ± 1.72 ; 16.78 %).

The representation of the same data in monthly means (Fig. 2b) shows that the first road kills were observed in March. Thereafter the number of traffic victims increased regularly to the maximum (19.20 ± 5.95; 20.92 %) in May (May *vs* other months: $P < 0.05$). From June to September, the number of animals killed remained at a low but stable level (between 10.00 ± 1.84 and 11.40 ± 3.09; variation between 10.89 and 12.82 %). From October on, the number of crushed animals diminished progressively and was very low in December (0.80 ± 0.65; 0.87 %) and became zero in January and February (December to February *vs* April to October: $P < 0.05$).

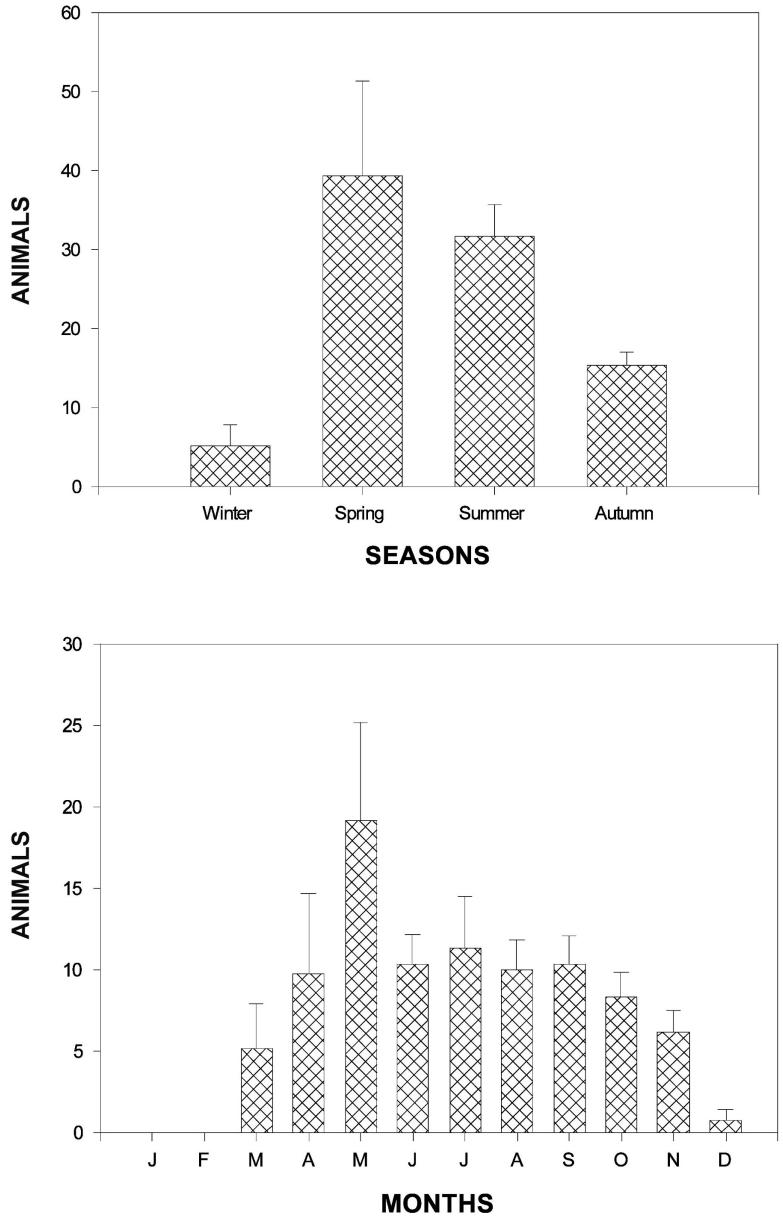

Figure 2. — Distribution of Algerian Hedgehogs killed on the road along the Soummam valley from 2002 to 2006 : (a, upper graph) on a seasonal and (b, lower graph) on a monthly scale. Mean ± SEM.

Interannual variations of the road kills of Algerian Hedgehogs in relation to ambient temperature variations in the Soummam valley

During the 5 years of this study, the number of hedgehogs killed was lowest in 2004 and 2005 (Tab. 1). Analysis of these data according to year and season showed significant variations occurring only during the spring seasons (spring 2004 and 2005 *vs* spring 2002, 2003, 2006: $P < 0.05$) but not between the years or other seasons.

In relation to the annual data of road kills of Algerian Hedgehogs, a possible effect of the climatic environment (typically Mediterranean) was examined through the study of annual and seasonal ambient temperature (Ta) fluctuations. From 2002 to 2006, the monthly means of the minimal (Ta_{min}) and maximal (Ta_{Max}) ambient temperatures (Fig. 3) showed that the coldest months were observed from December to March (Ta_{min} between 4 and 10 °C) and the minima in January and February (Ta_{min} < 4-8 °C), while the warmest months were between June and October (Ta_{Max} between 26 and 33 °C) with the maxima in July and August (Ta_{Max} > 30 °C). In winter Ta is always above 0 °C and, throughout the year, in spite of large day/night variations the amplitude [$Ta_{Max} - Ta_{min}$] is practically constant (between 8.4 and 9.8 °C).

When the number of traffic accidents was related to the environmental temperature a significantly higher number of road kills was found at a mean temperature of 19 °C ($P < 0.05$), i.e. at a range of Ta_{min} and Ta_{Max} between 15 °C and 23 °C. In the course of this study, the year 2006 was the warmest (mean: 19.08 °C) and 2005 was the coldest (mean: 17.45 °C) with the lowest Ta_{min} and Ta_{Max} occurring during winter and in the beginning of spring seasons. Despite similarities observed in 2005 between the lowest road kills and the lowest Tas, no statistical effect was established between interannual road kills and Tas variations. The variations of road kills are rather due to numerous various and indirect factors in relation or not to Tas.

Seasonal and monthly distribution of road kills of Algerian Hedgehogs in the Soummam valley as function of sex and age

Of the 459 hedgehog cadavers found during our study, we were unable to identify sex and age in 55 animals. Thus the number of traffic victims considered in the analysis of sex and age were 404, distributed in 3 categories: adult males, adult females and juveniles (unsexed) born in the same year.

The mean monthly data showed that the adult males were the most frequent traffic victims (36.20 ± 8.17; 45.30%), followed by adult females (25.20 ± 2.74; 31.19%) and juveniles (19.00 ± 3.20; 23.51%).

When data are plotted as a function of season (Fig. 4a), a different temporal distribution becomes evident between the 3 groups: the males were found first, from the end of winter to summer with a maximum in spring (24.80 ± 7.46 ; males spring *vs* winter and summer:

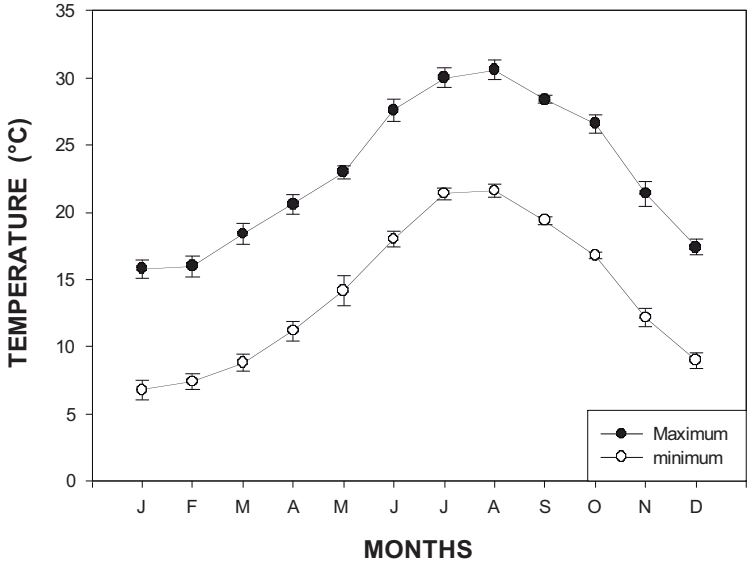

Figure 3. — Monthly means of the minimal (white circles) and maximal (black circles) ambient temperatures at Béjaia airport beween 2002 to 2006. Mean ± SEM.

P <0.05), the females mainly in spring (10.20 ± 2.72) and summer (12.00 ± 1.97) (males spring vs females spring and summer: P <0.05, and females spring and summer *vs* autumn: P < 0.05), and the juveniles in summer (9.60 ± 2.54) and autumn (9.40 ± 0.91).

The monthly distribution of crushed adult male hedgehogs (Fig. 4b) shows a considerable mean number from March to July (> 5.20 %) with high values from April to July (maximum in May: 10.60 ± 3.55; 13.12 %). Thereafter the number decreased progressively, becoming significant from August on (males; April, May, June *vs* August: P < 0.05) until it reached values close to zero from October to February. Female cadavers appeared only in April and in lower numbers than males (April, May, June; males *vs* females: P < 0.05). The maximal number was observed in May (5.80 ± 2.10; 7.18 %). This level stayed practically stable from June to September (3.96 to 5.94 %) but diminished in autumn. Minimal values were observed from October to April (0 to 1.98 %). Crushed juvenile hedgehogs were found from July onwards

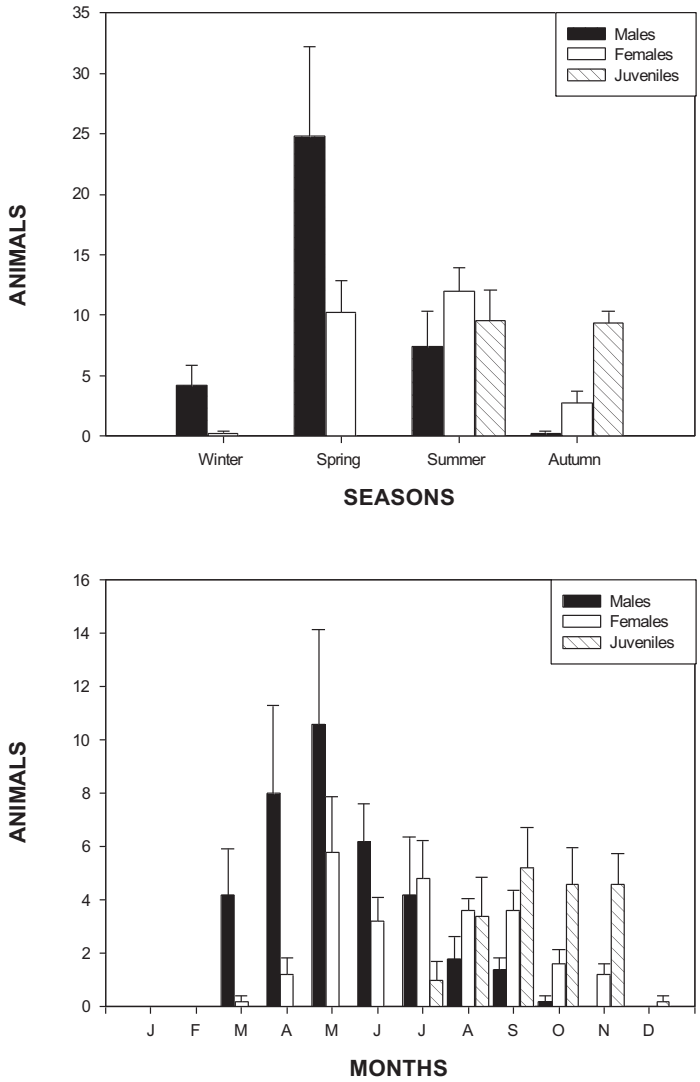

Figure 4. — Distribution of Algerian Hedgehogs killed on the road along the Soummam valley as a function of sex and age from 2002 to 2006 : (a, upper graph) on a seasonal and (b, lower graph) on a monthly scale. Mean ± SEM.

with peak values in September (5.20 ± 1.52; 6.44 %), and an elevated level in the first half of autumn in October and November (5.69 %) (juveniles [Sept., Oct., Nov.] *vs* males [Sept., Oct., Nov.] or females [Oct., Nov.] $P < 0.05$). In December the decrease was rapid and no juvenile traffic victims were found during winter. In the following spring, it was difficult to differentiate between juveniles of the previous year and adults.

DISCUSSION

This 5 year investigation on the numbers of Algerian Hedgehog (*Atelerix algirus*) victims of the traffic in the Soummam valley of Algeria constitutes an initial approach of the spatial and temporal distribution of this species in this region of North Africa. Therefore, our results were analysed and compared with those obtained in numerous countries of Western Europe in a close relative, the European Hedgehog (*Erinaceus europaeus*). The traffic accidents with animals are not random. Instead they are associated with movements (Morris & Berthoud, 1987). In the course of the study we tried additionally to investigate the possible impact of different ethological, climatic and physiological factors.

During the 5 years of the study in the Soummam valley, the total number of animals killed on the road was high (459 animals). However, due to a lack of detailed information on each sector of the traffic axis, it was not possible to correlate our data to the traffic intensity or estimate the total number of animals killed on the road per year. In certain European countries in which the traffic network is well developed and the traffic is dense, the estimations of the total number of hedgehogs killed on the road during one year are very variable (113 000 to 340 000 in The Netherlands [Huijser & Bergers, 1998] or 720 000 to 1 000 000 in former West Germany [Sponholz, 1965]).

Studies on the number of animal road victims can not provide a complete set of data, and can only indicate the minimum number of road kills on a measure interval. This is why certain authors (Berthoud, 1980; Morris & Berthoud, 1987) suggest multiplying the observed mammalian cadavers along a road axis with a coefficient of 2 – 5 to get a more realistic idea of the incidence of road kills.

In the Soummam valley, the annual index of hedgehog mortality on the road (I_{mr}) varies widely between 1.38 and 3.13 cadavers/km/year. In similar studies in Western Europe the I_{mr} in the European Hedgehog was between 0.01 and 5.6 animals/km/year (Reeve, 1994; Huijser *et al.,* 1998), and thus showed an even higher variability (Göransson *et al.,* 1976; Berthoud, 1980; Garnica & Robles, 1986; Huijser *et al.,* 1998). In countries with a very dense road network, the I_{mr} can be strongly elevated (Belgium: 13.5 [Holsbeek *et al.,* 1999] or The Netherlands: 11.9 [Tempel, 1993]). Concerning the I_{mr}, the results of our study on the Algerian Hedgehog in the Soummam valley are comparable to those with the European Hedgehog in numerous countries, but they are clearly inferior to observations in countries with a dense traffic network and high traffic volume.

The number of hedgehog road kills is highly variable according to the different sectors, but the strongest concentration corresponds to well defined locations. The sectors in which the number of cadavers is notable correspond to weakly urbanized villages (Haizer 30.5 %, Remila 22.4 %, Abadou 10.0 %, Allaghen 9.6 %, and El Azib 9.4 %). The different sectors represent common biotopes such as networks of hedges, outskirts of woods, embankments rich in herbs and shrubs, grasslands, and cultivated fields of the Western El Soummam. The elements of the landscape traversed, associated with the herb-rich road shoulders, constitute the essential factors which could attract the hedgehog, whose habitat should combine food availability, the possibility to hide, and structures facilitating orientation (Huijser, 1999). In this context, the herb-rich road borders form an attractive habitat for the European Hedgehog, and due to their continuity they serve as dispersion corridors (Doncaster *et al.,* 2001; Driezen *et al.,* 2007). These factors should be considered in view of the intensity of traffic mortality (Rondinini & Doncaster, 2002). The intersection of a combination of ecosystems with a frequented road creates an interruption of the landscape which becomes a fatal trap for the hedgehog. With regard

to the orientation of these linear elements (such as woods, borders of hedges or herbal bands) the number of hedgehogs killed on the road can vary: it is 20 to 27 % higher when the orientation is perpendicular to a road compared with a more parallel orientation (Huijser, 1999).

Small numbers of crushed animals were registered in sectors neighbouring the large and strongly urbanized agglomerations, such as Oued Ghir, El Kseur, Sidi Aich, Akbou and Tazmalt. Our observations are in agreement with a study in Belgium (Somers & Verhagen, 1999) which shows the variations of traffic mortality in European Hedgehogs depends on the surroundings: the number of road kills was high in the open landscape (2.11 / km), low in forests (1.33 / km) and reduced in urban areas (0.20 / km). In contrast, a study of hedgehog traffic mortality in the periphery of Wroclaw reported a preference for urban sectors (Orlowski & Nowak, 2004), because the linear elements of the environment constitute an ecological corridor. If in this context the number of crushed hedgehogs is not a fortuity but relies rather on certain local road characteristics (Huijser, 1999) it is also possible that the observed differences reflect differences in the population densities. These latter could depend on the surroundings, the availability of resources and also on the impact and intensity of traffic. Consequently, in the Soummam valley the habitat close to villages, with its hedges, herb-rich brinks, available resources but weak urbanization seems to be favoured by the Algerian Hedgehog as indicated by the high population density, while the perturbed habitats close to large agglomerations with a strong human influence, potential predators and a high traffic intensity are avoided in spite of a high resource availability. These different aspects should be investigated in detail in a future study for better understanding of the present results.

The distribution of Algerian Hedgehogs crushed on the road in the Soummam valley during the course of the year reflects the net seasonal variations: maximal in spring and summer and minimal in autumn and winter. Data analysis according to the month indicates that in the course of the year the first crushed animals were found in March, that the highest number of dead animals was in May, that the traffic victims declined in October-November and that no crushed animals were found between December and March. These results are similar to the data obtained on European Hedgehog traffic mortality in The Netherlands (Smit & Meijer, 1999; Reeve & Huijser, 1999). In this study too the traffic victim maximum was in summer (June, July, August) and the minimum at the end of autumn and beginning of spring (November - December to April). These data were confirmed in Belgium with capture – mark – recapture studies (Somers & Verhagen, 1999), which showed that the number of traffic victims increases gradually from April to August. Furthermore, the results obtained in the periphery of Wroclaw in Poland (Orlowski & Nowak, 2004) demonstrate in two hedgehog species (*Erinaceus europaeus* and *E. concolor*) that the number of road kills is elevated in summer (July, September) and in early autumn (October). The differences between our work and these studies are explicable by interspecies differences (Orlowski & Nowak, 2004), but more likely by differences in latitude and climate. The mild Mediterranean climate of Algeria allows a more extended active season than the continental climate with its pronounced seasons in northerly Europe. These climatic differences influence directly the two dominating seasonal cycles, hibernation and reproduction, and consequently the active seasons.

The number of crushed Algerian Hedgehogs varied slightly between years and was higher during 2002, 2003, and 2006 (Tas elevated) than in 2004 and 2005 (Tas lower). Because during the latter two years the number of crushed animals was only significantly reduced during spring, it was not possible to correlate these data to a decrease in the annual and seasonal ambient temperature. Though 2005 was the coldest year, the variations in road kills are certainly due to multiple indirect factors. The climatic differences can impact on reproduction and hibernation, and consequently modify the periods of locomotor activity. The coldest winter (in 2005) could have delayed the emergence from hibernation (Mouhoub *et al.,* 2008), and reduced the locomotor activity (and thus the number of traffic victims) in spring (late March to April). The cold temperatures at the end of winter – beginning of spring could also increase the mortality of hedgehogs (personal observations) and have a direct effect on the population at the emergence from hibernation. In the European Hedgehog, the effect of low temperatures (Ta < 9 °C) at the beginning of the active season is considered a limiting factor for locomotor

activity (Morris & Berthoud, 1987). The fact that the highest number of crushed animals was related to a relatively high mean Ta of 19 °C (Ta_{min} 15 °C and Ta_{Max} 23 °C) could indicate a higher sensitivity or a higher dependence of Algerian Hedgehogs to low ambient temperature. Similar effects relative to the decrease of Tas can also affect the reduction of activity in adults in early autumn, and in juveniles in early winter.

Examination of the number of Algerian Hedgehogs killed on the road in relation to sex and age shows clearly that the males are the main traffic victims compared with females (sex ratio m:f = 1.45). These data are comparable with those observed by Reeve & Huijser (1999) (sex ratio m:f variable between 1.1 and 1.5 depending on the months). Furthermore, the number of crushed males increased rapidly in March and reached a maximum in May, while the increase in the number of crushed females was later (from April) with only a slight maximum plateau between May and July. These net shifts observed in spring between males (early and high locomotor activity) and females (late and weak locomotor activity) can be correlated to differences in physiological and behavioural characteristics. Such sex differences are already described for the European Hedgehog, especially for the emergence from hibernation which is earlier in males than in females (Castaing, 1985; Saboureau, 1986; Saboureau & Castaing, 1986; Vignault & Saboureau, 1993). Furthermore, the earlier reactivation of gonadal function in the males supports the end of hibernation (Saboureau, 1986; Saboureau & Boissin, 1984). To search for females in spring, the males are very active during the rut period (Kristiansson, 1990; Huijser *et al.,* 1997; Reeve, 1994) and they have the largest home range (Reeve, 1982, 1994; Reeve & Huijser, 1999). This explains why males are the predominant traffic victims compared with females.

In summer and autumn, the differences between male and female traffic victims are inverted, with a lower number of males in August when the number of crushed females remains high, decreasing only in October. These distribution differences are also described for European Hedgehogs in relation to sex, regulation of reproduction, and entry into hibernation. Consequently, the males enter hibernation before females, and in males the gonadal regression precedes the onset of hibernation (Saboureau *et al.,* 1984). In late summer and early autumn, numerous young hedgehogs (born in spring and summer) were found dead on the road simultaneously to females. In European Hedgehogs, a notable number of traffic victims is also observed in autumn, which is due to the intense activity of juveniles born in summer. They forage for food to fatten before entering hibernation (Rondinini & Doncaster, 2002). The scarceness of food (invertebrates) in autumn (Sayah, 1996) can also increase the activity of juvenile hedgehogs and, thus, the risk of traffic accidents.

This study, spanning several years, analysing the number of Algerian Hedgehogs killed on the roads in the Soummam valley, provided some insights into the biology of this species. The comparison with European Hedgehogs allowed us to draw some conclusions about the relation of the Algerian Hedgehog to its environment, seasonal variations depending on sex and age, and endocrine changes involved in the regulation of locomotor activity and the annual cycle of reproduction and hibernation. In the Algerian Hedgehog, data in these areas are scarce and will be the object of future investigations.

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